REPORT RESUMES

ED 011 852 SE 000 922

IMPROVING SCIENCE EDUCATION. REPORT OF A NATIONAL CONFERENCE
OF SCIENCE SUPERVISORS (JUNE 14-17, 1966).
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PUB DATE JUN 66

CONTRACT OEC-4-000-967-0967
EDRS PRICE MF-$0.18 HC-$4.08 102P.

DESCRIPTORS- *CURRICULUM, *EDUCATIONAL OBJECTIVES, *FEDERAL LEGISLATION, *SCIENCE EDUCATION, *SCIENCE SUPERVISION, *SCIENCE INSTRUCTION, DISADVANTAGED YOUTH, LEARNING THEORIES, LABORATORY SAFETY, LABORATORY TECHNIQUES, OUTDOOR EDUCATION, SCIENCE EQUIPMENT, SCIENCE FACILITIES, TEACHER EDUCATION, AUSTIN

PROCEEDINGS OF A CONFERENCE FOR STATE SCIENCE SUPERVISORS ARE SUMMARIZED. MAJOR SPEECHES ARE CONCERNED WITH (1) STATE LEADERSHIP IN SCIENCE, (2) LEARNING THEORY, (3) THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE ELEMENTARY SCIENCE PROGRAM, (4) OUTDOOR SCIENCE EDUCATION, (5) TITLE III OF THE NATIONAL DEFENSE EDUCATION ACT, (6) TITLES I, II, AND III OF THE ELEMENTARY AND SECONDARY EDUCATION ACT, AND (7) THE USE OF GOVERNMENT SURPLUS PROPERTY IN SCIENCE TEACHING. ABSTRACTS AND SELECTED ASPECTS OF THE DISCUSSION PERIODS WHICH FOLLOWED THE SPEECHES ARE INCLUDED. RECOMMENDATIONS FOR LABORATORY SAFETY, THE USE OF LIVE ANIMALS, LABORATORY FACILITIES, TEACHER PREPARATION, THE LABORATORY APPROACH, SCIENCE AND THE DISADVANTAGED STUDENT, AND EDUCATIONAL OBJECTIVES ARE INCLUDED IN A SERIES OF GROUP REPORTS. (AG)

ED011852

# IMPROVING SCIENCE EDUCATION: A LOOK AT THE RESPONSIBILITIES OF THE STATE SCIENCE SUPERVISOR IN THE ADMINISTRATION AND IMPLEMENTATION OF TITLE III OF NDEA, STRENGTHENING INSTRUCTION IN SCIENCE, MATHEMATICS, MODERN FOREIGN LANGUAGE AND OTHER CRITICAL SUBJECTS, AND OF CHANGES IN THE SCIENCE CURRICULUM

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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A REPORT OF A NATIONAL CONFERENCE OF SCIENCE SUPERVISORS

JUNE 14-17, 1966

**Sponsored by:** The Texas Education Agency
Council of State Science Supervisors
United States Office of Education

SE 000 922

The Conference reported herein was performed pursuant to a contract, Number OEC-4-6-000 967-0967, with the United States Department of Health, Education and Welfare.

# FOREWORD

A National Conference of State Science Supervisors was held in Austin, Texas during the week of June 14-17, 1966 under the sponsorship of the United States Office of Education, Department of Health, Education, and Welfare. The two major objectives of the conference were to consider the responsibilities of the state science supervisor in the administration and implementation of NDEA Title III, strengthening instruction in science, mathematics, modern foreign language, and other critical subjects and to explore changes in the science curriculum. The following report has been prepared from materials presented at the conference.

In the front section of this report is a brief abstract for each major speech, a feature which it is hoped will be helpful in reviewing the major topics of discussion of the conference.

One of the unique features of the conference was the inclusion of small group sessions immediately following each speech. After a period for analysis and discussion in the small group sessions, the participants returned to a general session for further interaction with the speaker. We have tried to include some of the most oustanding points made by the speaker during this time of interaction in the section Highlights of the Discussion which follows each paper. It is, of course, impossible to capture in print all the meanings and intent of any spontaneous verbal response. However, we felt that many questions by the participants and responses by the speakers were worthy of inclusion in this report. Although it was necessary to exercise considerable editorial judgment in this section, it is hoped that the material will still retain some sense of its general context.

We are indebted to Mr. Jon L. Higgins, Graduate Assistant, Science Education Center, University of Texas, for his help in editing and summarizing the proceedings of the conference and, more particularly, in the writing of the sections on Highlights of the Speeches, Reports of the Interest Groups and Abstracts for the Major Speeches.

Austin, Texas
July 25, 1966

C. S. Story
Coordinator of Conference Activities
Program Director for Science
Texas Education Agency

### Editor's Note

Pursuant to Contract OEC-4-6-000-967-0967 with the U. S. Department of Health, Education, and Welfare, editing of manuscript material and distribution of the finished report is the responsibility of the Office of Education.

The manuscript has been examined and changes effected which, hopefully, have not altered the spirit and intent of the conferees' presentations.

Albert Piltz, Science Specialist
Walter Steidle, Science Specialist
U. S. Office of Education

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# ABSTRACTS OF MAJOR SPEECHES

## ABSTRACTS OF THE MAJOR SPEECHES

### State Leadership in Science - Addison Lee

The old image of the state supervisor of science as an administrator and clerk will undoubtedly be changed in the future to an image of important leadership. Curriculum programs supported by the National Science Foundation, such as the BSCS program, offer examples of how current advances affect the state science supervisor's role. The BSCS program produced not only new textbooks but also other new teaching tools such as the laboratory blocks. Indeed the common denominator of all the recently developed curricula seems to be more laboratory work, more student work, and the carrying out of more student investigations.

The evaluation of activity changes which occur in the classroom as a result of new curriculum materials becomes an important research problem. In 1964 a study which was designed to determine the extent of continued use of laboratory blocks noted that ½ of BSCS and institute trained teachers were then currently using laboratory blocks. Another recently completed study was designed to compare the classroom practices of biology teachers who used different curriculum materials. The results seemed to indicate that new curriculum programs have been successful in changing teaching practices. However, the results also showed that certain master teachers can also use the new effective methods without new curriculum materials. It is this kind of result from research studies which should be important in determining the future role of the state science supervisor

An example of other national programs affecting the state science supervisor is th National Science Teacher Association's Curriculum Committee. This committee has recently applied for a grant to revise and extend their work on identifying the major conceptual schemes and processes of science. In addition, several leading colleges and universities are also seeking support at the national level for an Educational Research Information Center. All of these developments will influence the future role of the state science supervisor. They point to a future role which can best be characterized by the word "leadership."

### The Cognitive Process in Learning Science - David Hawkins

Our educational system traditionally assumes that school children have a basic set of preschool learnings -- basic experiences and basic conceptualizations. Many children are deprived when seen in the light of this massive acquisition of tools, and this deprivation cuts across different classes and different cultures.

Conceptualization is seldom, if ever, accomplished by verbalization. Conceptualization involves the mental construction of models which serve as a scheme of analysis. It also involves a massive amount of redundancy of experience. But most schools make almost no provision for redundancy. Instead, the current emphasis is on finding the single best logical order, and this approach tends to obscure the fact that ideas are cross-connected. The teacher should not lead the child as much as he should put things in his path which will make it much more probable that the child will acquire the desired concepts. This may well involve the abandonment of certain kinds of order and organization, such as the lock-step curriculum; but it must never involve the abandonment of the enjoyment of learning.

## The AAAS Elementary Science Program - David Butts

Someone has defined science as "the belief in the ignorance of the experts". This definition implies that much of science is a "checking up" process. AAAS materials emphasize a process approach to science. They rely upon observations of the child and upon experiments. Teaching methods are also altered to take advantage of the process approach. For example, what the student can get across to the teacher is considered much more important than what the teacher can get across to the student. Telling is for time and not for teaching. To reflect this belief, there are no written materials for the children up to the sixth grade. Explanations in the classroom are considered to be appropriate only when they are consistent with the child's experience. This experience must come before labeling. In order for experiences to be meaningful to children they must be seen in the context of a variety of materials and situations.

## Outdoor Science Education - Matthew Brennan

Conservation is based upon the recognition of two basic concepts: the dependence of man upon environment and the responsibility of man to develop an environment fit for living. Today man has come face to face with the possibility of the destruction of his environment by such factors as population, pollution, pressure on resources, poverty of the environment, and environmental deprivation

However, decisions on conservation are apt to be made on the basis of whether or not the plans are economically feasible, aesthetically pleasing, socially desirable, and politically expedient, rather than on a scientific basis. Science educators have the responsibility to exert leadership in decisions about the use of resources so that these decisions will be decided on scientific bases. The school curriculum can help develop this leadership in the form of stress on learnings in environmental science, which can be integrated into all subject areas and levels of education.

Such education demands a total environment which would include outdoor laboratories as well as textbooks, films, TV, indoor laboratories, etc. The outdoor laboratory is particularly well suited for true research experience where there is no answer, for carryover of experience, and for the development of programs for the gifted child.

## Orientation and History of NDEA Title III - George Katagiri

The passing of the National Defense Education Act in 1958 has brought the number of science supervisors functioning in state departments of education from only a handful to nearly one hundred. State departments of education have played an important role in changing science instruction away from the traditional reading and discussing methods of teaching. Today not only teachers and parents are concerned with science education, but businesses and industries, as well as colleges and universities, are also realizing the significance of changing science curriculum. Because many aspects of science education are evolutionary in nature, the problems and duties of the state science supervisor change from year to year. These changes depend more and more upon research findings. However, since research in science education is limited, guidelines need to be formed in meetings such as this conference.

### The Present and Future of NDEA Title III - Lee Wickline

Expenditures for science under NDEA Title III seemed to reach a peak in 1964. Expenditures were down from $49 million in 1964 to $42 million in 1965. This drop reflects the addition of five subject matter fields to the NDEA Act, as we as the passing of the Elementary and Secondary Education Act. This drop in expenditures can be attributed to several causes. Among the most probable, however, are increased concentration on the Viet Nam situation and a feeling that the ESEA legislation could purchase some materials formerly covered under NDEA Title III. However, this latter reason does not appear to be a reality. In fact, some expenditures seem to be accelerated under NDEA because of the passage of ESEA.

There is now some discussion under way in the U.S. Office of Education towards fitting together recent legislation into some kind of overall program. This discussion envisions the use of Title IV of ESEA to support research of ideas and new educational programs. Title III of ESEA would be used for the dissemination and diffusion of information about these ideas and programs. Later, NDEA Title III and ESEA Titles I and II would be a source of large scale adoptions of such programs and projects.

### ESEA Title I and Compensatory Science Education - . H. Phillips

Title I of ESEA was enacted to provide funds to local school districts for providing better educational opportunities to deprived children. Deprived children are characterized by their use of physical learning, slowness in learning, and a different background of experiences. A science curriculum for such children must extend from the preschool years through high school. It will rely heavily on providing sequential experiences which will develop the concepts necessary for continued intellectual growth.

### ESEA Title II and Science Materials - Milbrey Jones

Title II of ESEA provides one hundred million dollars to the states for the acquisition of school library resources, textbooks, and other instructional materials. Most states have given priority to school library resources for the first year of Title II. Teachers and librarians in elementary schools will have special need for assistance in selecting and using materials. In addition, teachers will need help in learning how to utilize newly acquired audio-visual materials. In these areas, subject specialists and state science supervisors can be of great help.

### ESEA Title III and Innovative Science Programs - Lee Wickline

Two out of every three projects proposed for ESEA Title III funding have been rejected because they really did not involve innovative or exemplary ideas. Projects involving new construction, or which request more than fifty percent of the total budget for equipment and materials are automatically being rejected. An additional weakness of project proposals is a lack of awareness of pertinent research or programs currently being carried out. Many proposals are not specific about procedures to be followed.

State supervisors of science can be helpful in identifying outstanding innovativ projects. In addition, they can take the responsibility for helping smaller school districts learn how to write good project applications.

# MAJOR SPEECHES AND HIGHLIGHTS

# STATE LEADERSHIP IN SCIENCE

Dr. Addison Lee
Director, Science Education Center
The University of Texas

In discussing the topic "State Leadership in Science," I would like to think in terms of yesterday, today, and tomorrow--in particular, the image of the state science supervisor of yesterday, the events of today that attack the work of the state supervisor, and some suggestions for the state science supervisor of tomorrow.

At the risk of speaking in poor taste, I would like to suggest that yesterday's image of the state science supervisor as a leader in science education, as well as many other state supervisors in their fields, is not a very good one. I'm afraid that many of the professional scientists and science educators have thought of the state science supervisor as strictly an administrator, a clerk, a cataloguer, keeper of inventory, and not as a real leader in the field of science education. I'm afraid that many of the science teachers have thought of the state science supervisor of yesterday as a type of educational policeman. It has been said that one may define a government official as one who writes letters that other people sign and one who signs letters that other people write. To paraphrase this description, the image of the state science supervisor of yesterday might be described as one who follows guidelines written by someone else and writes guidelines that are going to be followed by someone else. None of these descriptions implied any real leadership in the field of science education. It may be true that the description that I have presented is an erroneous one; I am certain it is erroneous in some specific instances.

However, what I believe to be more important is to consider what the role of the state science supervisor should be than to try to determine the accuracy of the image of yesterday's state science supervisor. In my opinion, the role of the state science supervisor is and should be a very important one. Its importance has been particularly intensified in recent years for a number of reasons. These reasons include recent legislation that has made more money available for education. They include the new developments that have taken place in curriculum organizations and reorganization. They include the recent instances by colleges and universities, and local school systems in the development of programs of in-service training of teachers. They include the results of educational research that are now spreading the field of education and psychology into areas of curriculum development and evaluation. They include the results of a knowledge explosion and also a population explosion They include the effects on education of a changing society. All of these developments have important implications for leadership by state science supervisors. A comprehensive report of the events of the day is far beyond the scope of this discussion. At best, we can only indicate a few examples and attempt to identify some common denominators of these events that may be important to the state science supervisor in his leadership role.

The events of today will be considered under three general headings: program supported by the national government, other national programs, and state and loca programs. In addition, I would like to consider some results of current research, all of this in the field of science education.

## Federal Programs

As all of you know, the federal programs in science education are supported by the United States Office of Education or the National Science Foundation. An examination of the tentative agenda for your conference here indicates that you will have an opportunity to hear and discuss a number of programs that are supported by the United States Office of Education; and in view of the presence of Mr. Shedd, Dr. Wickline, Dr. Jones, and other speakers who will participate in this conference, it would be most inappropriate for me to do more than recognize the important contributions that are made by the National Defense Education Act, the Elementary and Secondary Education Act, the Higher Education Act, and other legislation that is being implemented at the national, state, and local levels. In the interest of coverage, however, I would like to indicate that these programs do include provisions for scholarships, fellowships, for students at various levels; the development of research and development centers at various institutions in the country, the development of regional laboratories, the support of various state and local projects in education.

Most of the other federal programs are supported by the National Science Foundation and have been listed in the booklet Science Course Improvement Project published by the Foundation. Dr. Henry W. Reekin, Associate Director of Scientific Personnel and Education for the Foundation, has described the objectives of these programs as follows: "Good teachers and good schools have always worked individually to give students the best educational fare they could. More scientific and technological discoveries have been made in the past fifteen years than in all previously recorded time. Powerful new insights are being gained into the fundamental structure of major areas of inquiry. More traditional assumptions about what students at a given level of development can learn are increasingly found to be misleading in many ways. Finally, society can no longer afford to wait a generation for more or new knowledge to make its way gradually to school and college programs." In the last few years mathematics, scientists, engineers, and educators have taken up these new educational challenges with great vigor. Working together and aided by increasing public and private support for educational research and development, they have undertaken a number of fresh approaches to the improvement of school instruction in mathematics and science. In colleges and universities, research scientists have taken an increased interest in undergraduate instruction. The aim has been to see that instruction presents contemporary knowledge as well as contemporary viewpoints on knowledge established earlier.

In many cases it seems best to start anew rather than merely to patch up older courses. A distinctive feature of many projects is the effort made to go beyond the presentation of what is known and to provide students with experience in the processes by which new facts, principles, and techniques are developed. I am sure that you are all aware of the problem of curricula, that the problem of curriculum development of science education involves development of program K-14 at least, and probably beyond, although attention to programs beyond the grades 14 is given largely by groups other than science education. Likewise, there are many other National Science Foundation programs involving institutes for teachers, visiting scientist programs, and others. The following is a very brief listing of some of the programs that have been supported by the National Science Foundation at the different levels in current development as described in the booklet mentioned previously.

At the elementary level there is the Scientific Curriculum Improvement Program, headed by Robert Karplus at Berkeley; the Elementary School Science Project at the University of Illinois headed by Atkin and Wyatt; the Elementary Science Study continued by Educational Services Inc. in Watertown, Massachusetts; the AAAS Commission on Science Education of which Hohn Mayor is director and about which you will hear more later in this conference, as I understand. At the junior high level, some of the examples include the Junior High Science Project at Princetown headed by Dr. Ferris, the Physical Science Study Committee work on junior high physical science under F Dr. Haber Schaim, the ESI and MIT, New York Science Curriculum Program. At th senior high school level, Physical Science Study Committee's PSSC Physics Program; the Chemical Bond Approach Program, CBA; the Chem Study Program, CHEMS; and the Biological Science Curriculum Study, the BSCS.

As most of you know, I have been more actively involved in the BSCS Program than in any of these other programs. Thus, I hope I will be forgiven if I spend more time in discussing more aspects of that program than some of the others--not because I think its any more important, or necessarily any more illustrative of some of the common denominators of science, but because I know more about it.

Part of the nationale of the BSCS Program has been stated in one of the publications about a teacher's handbook. What was needed, it said, was a collaboration among the different companies responsible for different texts; between the scientists on the one hand and the teachers on the other; between close contact with the field of knowledge about teaching and education. Teachers have now come out of their schools, educators out of their colleges and universities, and scientists have come out of the laboratories; these three groups together have begun to learn how to communicate and collaborate to produce better materials for our schools.

The BSCS texts are one of the results of this group's collaboration. BSCS accepted the obligation to bridge the gap between these indispensable sources of good education endeavor. Its aim was not merely to transcribe materials from the most recent scientific journals and textbooks, but to select the materials most appropriate for the training of our youth, to develop and present these materials so as to contribute to the development of attitudes and skills as well as the knowledge, and to recognize the fact that for many students high school is terminal. The materials were not to be confined to elementary facts and generalizations, but they were to constitute something broader and larger--a reflection of the principles and emphasis on science as a whole.

As you probably know, BSCS has developed three versions of a modern high school biology (the blue, yellow, and green versions) each with laboratory manuals and teacher's guide. In addition, they have developed a second level biology program, a program of special materials for the slow learner or the unsuccessful learner or the underdeveloped learner. In addition, a series of bulletins and special publications and pamphlets, technique films, and single concept films have been produced. Likewise, a series of biological investigations for high school students has been published and a series of laboratory blocks has been developed. Now in direct participation in this program I have been primarily involved in the laboratory block program. Using the excuse that a concrete example is often effective in providing an explanation or understanding, I would like to illustrate one way the learning experiences have been designed in this' program with an example from one of the laboratory blocks developed by the committee on innovation in laboratory instruction. I think it is fair to say, although I'm obviously biased, that the BSCS laboratory blocks are one of a truly different teaching approach or teaching which offers promise in fulfilling many of the important objectives of this new program. All the new programs properly ask this: "What is the function of the laboratory?" It can be used to give demonstrations or to teach technique. Indeed, these are the most common practices that are now used in the laboratory. The laboratory block provides the basis for the student and teacher to suspend other work in the course for a six-week period, a six-week block of time, to carry out in the laboratory a series of investigations on a specific topic following the pattern that a scientist might employ if he were studying the same problem and beginning at the same place as the student, insofar as his knowledge of that topic is concerned. Questions are posed but answers are not given. However, the student is provided with instruction in technique for obtaining data that he may interpret and thus provide him with possible answers to the questions posed. Stated in another way, the laboratory blocks do not just happen, they have to be taught. For example, in the laboratory block on plant growth and development, the students working in squads of four to six are given a bag of corn seed. They are asked, "How many seeds are in this bag? How many seeds in this bag are alive? How could you find out?" Most students know that one way to find out whether seeds are alive or not is to plant them.

So we ask, "Is there any other way?" Most students do not know any other way. So we tell them. Yes, scientists have found a way to determine seed viability by exposing the cut surface of the embryo to a special reagent, tetrazolium chloride. If the seed is alive, it is respiring and the action released in respiration will combine with the reagent to form a pink compound. Thus we have two techniques, the germination tests and the tetrazolium test. This is a variable to provide information on the question that was originally asked, "How many seeds in this bag are alive?" However, one element is missing: the control. The missing element is identified in class discussion and in the actual investigation carried out by the students. These are divided into two lots, half of them killed by boiling to serve as a control. Equal numbers of seed unknown to be living or dead and those known to be dead--the boiled seeds--are subjected to the germination test and to the tetrazolium test. The results are then discussed. You may find, for example, that 80 percent germinated in the germination test and 92 per cent were shown to be viable by the tetrazolium test. If these tests were supposed to tell us how many seeds in the package were alive, why are not the results identical? A number of explanations are discussed, but one in particular provides the basis for subsequent investigation to study this problem in depth. Could it be that there is something other than being alive that's involved the germination test and 92 per cent were shown to be viable by the tetrazolium test.

If these tests were supposed to tell us how many seeds in the package were alive, why are not the results identical? A number of explanations are discussed but one in particular provides the basis for subsequent investigation to study this problem in depth. Could it be that there is something other than being alive that's involved in germination? Conditions of the environment, water supply, oxygen supply, temperature, air, and light are all possible answers. All of these questions are subject to investigation. That's what the student does--investigates one question after another involving the execution of simple experiments in the beginning, and later more sophisticated experiments involving the control of specific bands of light and their effect on cytochrome formation in certain kinds of matter. The student also learns not to carry his interpretations too far, not to over-generalize. For example, he discovers that the volume of water uptake during seed germination is quite different in different kinds of seeds. He is asked if the seed has taken up a maximum amount of water and if he has learned anything about the rate of water uptake. He is then asked to design experiments to investigate these questions. Most students do not have time during the block to do all of the experiments they design, but they do gain some understanding of what is involved in experimental design. Well, what are some of the common denominators, not only of the BSCS Program but of all of the other programs, both at the elementary level, junior high level, and senior high level? They certainly include three common denominators--increased emphasis on more laboratory work, increased emphasis on more student work, and increased emphasis on the carrying out of real investigations.

What's happening at the college level? At the college level, various commissions for education have been setup by the various scientific professional societies. The Commission on Undergraduate Education in the Biological Sciences (CUEBS) is illustrative of this group. Their objectives have been stated in a recent CUEBS Newsletter. The commissions are designed to study the problems of undergraduate education; to help in the exchange of information among those engaged in the improvement of instruction; to cooperate with individual faculty members, institutions, society, education committees, and other commissioners; to coordinate efforts, provide advice, stimulation, encouragement and make recommendations. However, the commissioners have no desire to prescribe any sort of standardized national program. For the present at least, they have no plans for writing textbooks, which has been done by other groups such as BSCS working at the secondary level. The college commissions are in every case independent of the high school groups in the same discipline. What has been done to articulate these programs--elementary level, junior high, senior high, college? The answer to this question unfortunately is that little or nothing has been done to articulate these programs.

## Other National Programs

Although there are a number of other national programs and other programs with national implications, I will take time to mention only one in this discussion. This one is the work of the National Science Teachers Association Curriculum Committee and the subsequent publication of the National Science Teachers Association of Theory into Action. If you have not seen this document, I strongly recommend it for your consideration. The publication includes among other things: (1) a discussion "toward a serious science education consistent with modern science" by Paul De Hart Hurd, (2) a list of conceptual schemes and the processes of science developed by a blue-ribbon committee composed of scientists and science educators called together by the National Science Teachers Association, (3) some suggestions for planning a local action committee--a local action program for implementing curriculum development in science. It is not the scope of this discussion to go into detail concerning the information in this publication. However, it should be noted that it deals particularly with the development of an integrated curriculum K-12 and provides a philosophy and some suggestions for the development of such a program. It should be noted in passing that, following the publications of the conceptual schemes, some debate occurred among scientists and science educators concerning this. In particular, some scientists insisted that the conceptual schemes were particularly representative of the physical sciences but did not adequately represent the biological sciences. As a result of these considerations, and in an effort to improve the potential and possible use of these conceptual schemes in curriculum development, the National Science Teachers Association has recently applied for support to expand and develop the conceptual schemes in such a way as to make them more useful for curriculum makers at all levels. It is hoped that this proposal will be supported, carried out, and result in 9 a revised document which will be more helpful than the existing one.

## State and Local Programs

Again, in view of the nature of your tentative program at this conference, it would appear to be presumptuous of me to discuss state programs to any extent in this presentation. On the other hand, I am fully aware and I know you are of the many state programs initiated by state education agencies or departments as well as a number of local programs initiated by local school systems.

## Research

It was indicated earlier in this discussion that some increased emphasis on research in the area of curriculum development is taking place. I think it is particularly important for state supervisors to examine this research in detail and analyze and identify the implications it may have for their own work. Sometime ago a number of science educators from leading universities in the country along with officials from the United States Office of Education convened at an informal meeting in the National Science Teachers Association Convention and conceived the idea of organizing a confederation of science education centers for the purpose of developing cooperative research and exchanging research information. The initial effort resulted in a conference held in November, 1965, at the Ohio State University under the leadership of Dr. John Richardson and Dr. Robert Howe. The problems of research in science education were discussed in detail at this conference, and a number of problems and issues for further study identified. Since the conference, Dr. Richardson and Dr. Howe have taken the leadership in seeking support for the development of an Educational Research Information

Center (ERIC) to be set up at the Ohio State University, but to serve centers and officials across the country. One of the first tasks of this center will be to identify meaningful research that is being done in the field and make that information available to science educators and science supervisors over the nation.

Among the most important problems for research in science curriculum development is the evaluation of actual changes that occur as a result of the use of new curriculum material. There are at least two important aspects to this kind of research. One phase deals with the extent to which new curriculum materials are actually being used and the reasons for their use or lack of use. The other phase deals with the extent to which use of the materials actually resultsin changes in teaching program, teaching behaviour, and student learning. Although there have been a number of researches along these lines, I would like to describe two which have been carried out at our institution as illustrative of the type of work being done.

The first of these deals with a study conducted in 1964 to determine the continued use of laboratory blocks by teachers who were involved in initial try-out programs and were given training in the use of laboratory blocks in special summer institute programs. A number of things were learned in this study, and, in particular, I will call your attention to the following: Approximately one-fourth of both BSCS-trained and institute-trained teachers are currently teaching a laboratory block. Slightly more than one-half of the teachers responding have used at least some portion of the laboratory block without teaching the block in its entirety. Class size, inadequate funds, inadequate length of laboratory period seem to be the major administrative obstacles identified by teachers as reasons for discontinuing the program. Inadequate preparation time was also identified as a prominent reason for not teaching the laboratory block. The latter reason probably reflects administrative problems, although in some cases it may indicate a teacher's lack of commitment to the program and/or a teacher's lack of willingness to spend the time necessary for preparation. About twenty per cent of all the reasons offered by teachers for no longer teaching the lab block can be attributed to the teacher's lack of commitment to the value of the program in relation to reduction in time from regular course procedures. It seems to me that the results of this study have a number of implications for state science supervisors and other such supervisors, particularly the reasons for discontinuing the use of particular materials in relation to the nature of those materials.

The next research that I would like to describe includes a comparative study of classroom practices and rationale of high school biology teachers using different curriculum materials, and a study of the nature and extent of laboratory work being done by high school biology teachers using different curriculum material--specifically BSCS materials on the one hand and teaching new biology programs not using BSCS materials on the other. These studies have been carried out by two of our graduate students Mr. Leonard Kochendorfer and Lehman Barnes and myself. Three groups of high school classes were selected for this study as follows:

> Group EB consisted of one classroom of students from each of 22 teachers who were identified as having had considerable training

and experience in the BSCS Program. The mean number of years of experience in teaching BSCS by this group was five years.

Group BB consisted of one class of students from each of 21 teachers who were identified as not having had any previous experience or training in the BSCS Program, but who were using the materials for the first time.

Group NB consisted of one classroom of students from each of 21 teachers who were identified as using curriculum materials other than BSCS.

The study involved the development of an instrument designed to measure biology classroom and laboratory activities. The biology classroom activity checklist was developed to determine the degree to which the laboratory and classroom practices of a given teacher conformed to those judged to contribute to the attainment of BSCS objectives as determined by careful review of the philosophy of this program and evaluated by a panel of judges known to be familiar with these materials. The biology laboratory activity checklist was concerned solely with the nature and extent of laboratory activities although it was developed in the same way as the classroom activity checklist. These instruments were given to students in the selected classes described above. A few examples of the items which students checked as being done or not done in their classrooms are as follows:

1. In reading the text, we are expected to know most of the details that are stated there.
2. The textbook and the teacher's notes are about the only sources of biological knowledge that are discussed in the class.
3. We are seldom or never required to outline sections of the textbook.
4. Much of our class time is spent in listening to our teacher tell us about biology.
5. My teacher often asks us to explain the meaning of certain things in the text.
6. We students are often allowed time in class to talk among ourselves to talk about ideas in biology.
7. Our tests include many questions based on things we've learned in the laboratory.
8. Our tests often ask us to write out definitions of terms.
9. My teacher usually tells us step-by-step what we are to do in the laboratory.

10. We spend some time before every laboratory in determining the purpose of the experiment.

11. We often use the laboratory to investigate a problem that comes up in class.

12. Many of the experiments that are in the laboratory manual are done by teachers or other students while the class watches.

13. The data that I collect are often different from the data collected by other students.

14. We talk about what we've observed in the laboratory within a day or two after each session.

15. Our teacher often grades our data books on neatness.

16. I feel that I gain a better understanding of the nature of scientific investigations as a result of the teacher's lecture than I do the experiment.

17. Our teacher feels that the laboratory is the most important part of the biology course.

We originally had about ninety items such as those in this checklist--we narrowed it down in each instrument to about sixty, although there were several items that overlapped in some aspects. In addition to these checklist instruments, several other instruments were given to the teachers and students in the class. The students were given the BSCS Processes of Science Test. Teachers were asked to complete an Aptitude Inventory concerning their reaction to the types of programs and a checklist of equipment and facilities available to the laboratory was checked by the teachers. It is obviously impossible for me to provide you with a complete analysis of the data obtained in these studies. As a matter of fact, a complete analysis has not been done. However, we are far enough along to be able to determine that students in the classes of the experienced BSCS teachers provided a significantly higher set of responses judge to be promoted by the BSCS rationale and philosophy, whereas the students of beginning BSCS teachers gave the next highest set of responses. On the other hand, the data revealed that there was considerable overlap in the case of individual teachers. For example, one of the non-BSCS classes responded higher than thirteen out of 21 classes of experienced BSCS teachers. In contrast, classes of an experienced BSCS teacher gave as low or lower responses when compared to twelve of the non-BSCS classes. Complete analysis of these data reveal a number of other interesting comparisons and correlations. The point I'd like to make here is that data such as these are important to state science supervisors and other science supervisors and the curriculum makers in what they teach us about the actual practices that go on in the classroom and the actual results of using new curriculum development. It seems to me that they say, among other things, that new curriculum programs have been highly successful in changing teaching practices. On the other hand, they say that there are some teachers not using these materials who are still teaching according to the philosophy and rationale that is being promoted by these programs. Thus, although it is not absolutely necessary to have new curriculum materials, we must recognize, as I'm sure you do, that there are not enough master teachers to even begin to accomplish the purposes that the development of potentially effective curriculum materials would suggest.

Recently, Burkheimer of Michigan State University has distributed a preliminary analysis of his study of the science supervisor's role in the selection and use of curriculum material. The object of the study was to determine and analyze the role of the science supervisor in the selection and use of science curriculum material as viewed by supervisors and teachers involved in the implementation of the National Science Foundation sponsored project materials compared with those involved in the implementation of commercial science curriculum materials. The results indicated, among other things, that the group using commercial science curriculum materials placed greater emphasis on materials that emphasize: (1) teacher demonstration, (2) class content units, (3) qualitative observations and explanations, (4) science facts and principles and (5) explanations to develop concepts. A similar analysis indicated that the group using the National Science Foundation sponsored science project materials considered those curriculum materials to be of greater importance that emphasize: (1) individual laboratory approach to teaching and learning, (2) the use of laboratory experiences as a primary source of information, (3) the elements of scientific method, (4) the quantitative approach to science education, (5) the investigative approach to concepts of element, and (6) tests to measure the child's ability to use the methods of scientific inquiry.

## Indications for Tomorrow

At this point in the discussion and against the background of events of today, I would like to suggest some obligations and potentials for leadership of state science supervisors for today and tomorrow.

A. You have the obligation and potential to continue the administration of programs provided for under the various federal and state agencies, but you have the responsibility to make this administration more than clerking, cataloguing, and pencil-pushing. The implication is to do what you can to help make a given program a success; not to find out what the program users are doing wrong and telling them their mistakes. Help school systems to develop and carry out programs in the most effective way; don't force them to spend all or nearly all of their time explaining why they did what they did. We are more and more becoming a nation of spies on each other. Look for example at the financial encouragement the Internal Revenue Service gives you to serve as a tattletale on your neighbor on matters relating to income tax. Equally important, please do not be a slave to averages. Average is mediocre. The reason you have an average is that there are some high and some low. When you pull a high down to the average, then you lower the average and thus you promote even more and greater mediocrity. Yes, continue to administer the programs--we realize that you have a legal responsibility here to do this and that you are serving in that capacity. On the other hand, if you are going to be a leader, I think that you will have to be more than a clerk or a cop. Now don't get me wrong; I do not object to clerks or cops. They are both very important to our society; but in my opinion, to exert leadership in science education, you must spend most of your time as a professional science educator in a different role.

B. You have the obligation and the potential to identify problems and services where you can offer greater contributions in your state. These problems may involve the locations of local areas of particular need. They may involve identification of gaps where additional work needs to be done. They may involve articulation of science programs. They may involve identification of specific research problems. They may involve the need for continued and new cooperation of various other agencies and organizations. They may involve a look at your own state organization and possible reorganization in terms of activity patterns and personnel, and many other things which you are, no doubt, in a better position to evaluate than I am.

C. You have the obligation and potential to continue to develop counseling and administrative services for in-service training programs at the local and state levels. I realize that many states have already undertaken a number of in-service programs and they work with many other groups either in a counseling, administrative or liaison capacity in developing and carrying out these programs. It is obvious, however, from the development of new curriculum materials, and the indication that we are getting from research as to the reception of these materials, that a great deal of in-service training remains to be done and should be done. The state science supervisor has an important leadership role to play in these programs.

D. You have the obligation and the potential to re-examine the role of educational research at the state level. There are many studies which can best be done through the offices of the state science supervisor. We still do not always have accurate up-to-date information on teachers, teacher certification, student courses, special programs, library services, equipment, space, and special needs in the field of science teaching at all levels; but equally important to the acquisition of this material (most of which I am sure you probably have available in most states if not all) is the dissemination of this material and this information where it can be most useful. The colleges and universities need to have such information in order to plan their programs. Individual school systems and officials of such systems need to have this kind of information in order to plan their programs. Careful examination of the National Education Association Research Division and its work might prove useful in planning the format for the type of program I am suggesting here.

E. You have the obligation and potential to continue cooperation with colleges, universities, and other institutions in your state in the development of various programs of in-service training, joint research, and others. I realize that many, if not all of you, are already cooperating in many ways with these institutions. I am not belittling this effort at all. Rather, I am suggesting that there may be other opportunities in this area which should be explored and would increase your leadership potential in science education in your state.

F. You have the obligation and potential to continue the operation you have with various state and national professional organizations such as the National Science Teachers Association, National Association of Biology Teachers, various state science teachers associations and various state academies of science. Again, I realize that you are probably already involved in cooperation with these agencies, again I am suggesting that you examine what else you can do that might improve efforts in behalf of science education.

G. You have the obligation and potential to try to keep as up-to-date as possible in the areas of legislation, educational research, changes in the society in which we live and in science itself. The population explosion and the knowledge explosion have already been emphasized over and over by teachers, the press, and other means of communication. I am sure that you have heard many times that our scientific knowledge keeps doubling every ten years if not increasing at a greater rate. I am sure that you have thought about the implications that the changes which are occurring in legislative education and sociological matters have for your role as a leader of science education in your state. I also realize what a staggering task it is to try to keep up-to-date in these areas. It is, of course, impossible for you to become a specialist at the research level, for example, in all of these fields. On the other hand, there are other ways to keep up to date and other things which must be done to offer you an opportunity to do so. Perhaps it would be well to consider a series of conferences such as this one, in which you would deal on a specific topic for each conference by bringing in appropriate top-level specialists to discuss the frontiers of their fields today. Therefore, you would use this means of communication as one way to keep reasonably up-to-date in the various fields of importance to you as a leader in science education.

In summary, the challenge to state science supervisors is that you do become a leader in science education in your state. You do this by stimulating and helping to bring about real change in science teaching in your state. If the programs and activities in which you are engaged do not accomplish this purpose, the challenge is to create new programs and activities which offer promise of bringing about the changes needed.

### Highlights of the Discussion of Dr. Lee's Speech

Many questions were directed at Dr. Lee concerning the need for more communicatio
between secondary and college science teachers, and state science supervisors

and teacher-training institutions. One group asked, "Since so many state departments have legal responsibilities for science curricula in the state, how can closer communication be established between national curriculum developers and the state department of education for the purpose of evaluating and implementing such curricula?"

Dr. Lee replied, "I think that the curriculum programs would welcome any moves in this direction; there should be possibilities for some sort of conference here or for an exchange of information on this issue. On the other hand the terminology you have in the first part of the question is interesting and recognizable as being very clear-cut. I recognize very much that you people have certain legal responsibilities, and in a sense, this is the kind of thing I was trying to drive out, in part, with discussion here I look upon you more as a professional science educator, and I would hope that your work would prove more in that direction and a little bit less in the direction of the watchdog type of situation. I'm not objecting to the watchdog: I think this is necessary and is a fundamental part of our work, just as business managers and presidents and deans and all sorts of people at the college and university level do have certain responsibilities. It is an important responsibility. Because of the watchdogs, those of us who have teaching and program planning and research work as our responsibility have a little more freedom to proceed. It would be my hope that some kind of reorganization within the agencies and the departments might permit some further development of the science education aspect of this as opposed to the strictly legal responsibilities that you have.

My speech was about state leadership in science education and not what the colleges and universities are not doing; but, ladies and gentlemen, if that were the topic of my speech I can say many things that I think need to be done by professors and officials in colleges and universities. The fact that it isn't in there doesn't mean that there a great deal that we ought to be doing. I think there are many things that we should be doing that we are not doing along that line. However, I don't feel completely pessimistic about this because I believe that things are opening up, that we are beginning to get better acquainted and are beginning to establish better lines of communication in this area. Just to give you one tiny little example (there are examples of all magnitudes here), one piece of work that we have been doing in our Center at our University has to do with a critical study of the library materials, references, use and so on with the various textbooks that have been adopted in the State in biology. What came out of this study was the number of things that I think are potentially useful to teachers and librarians in the state; and so I made some contact with State officials in this State. We visualize that as soon as we can get a little further along with this study and put it together, the State may be able to disseminate this information to biology teachers, librarians, and others who might be interested in this sort of thing. Now this is one tiny example of ways which I think closer communication might be promoted."

One group suggested that educational television might be used to strengthen the leadership function of the state science supervisor. With regard to the use of educational television in the classroom, Dr. Lee commented, "I do not think that television is going to replace the teacher, or that programed learning is going to replace the teacher. I think these are all tools, just as the carpenter instead of the old hand saw now has one of those little motor jobs he pushes along on the board and gets through faster. He has a lot of other fancy machinery. These are tools, but I think the problem in education is so big that it is a mistake for us to overlook looking at all of the techniques that are available. Perhaps you see that all of the answers are not in the television itself, but how you use it. Maybe the answer isn't in a particular programed learning book that you picked up or other equipment for that matter; maybe it was the way it was put together. You may have to do some more studying and research. I think one of our biggest problems is that we do not have enough evaluation instruments. Evaluation was mentioned several times. This is one of the breakthroughs we are trying to make now--in putting together some instruments. We know very well they are highly imperfect. What they measure may not be what we think, but it is a start. We hope that we have an opportunity to make these available--that you can take them, tear them up or start over, but maybe comeout with a better one. We do have to have better instruments in order to measure someof the things we wantto measure in educational research."

# THE COGNITIVE PROCESS IN LEARNING SCIENCE

Dr. David Hawkins
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The things I want to say are not, I hope, as fancy as the title, which you all recognize as psychologist's jargon. I want to try in some way to tell you of some of the thinking that I have been trying to do in understanding the learning of young children in the field of science (although I don't think the kind of thing I want to talk about is peculiar to science at all). I don't know a great deal about the cognitive process and, moreover, I am emboldened to think that not many other people do either. I would just like to give you some of my reflections partly based on the observations of young children and partly based on the observation of ourselves trying to work with young children. I am trying to find some rationalization for the direction in which we have increasingly found ourselves going in our work with teachers and children. This was not something that was anticipated by me when I got into the work; it is a result of the influence on us and on myself, in particular, by teachers. I am not by temperament humble, but I feel humble nevertheless in having learned more than I have taught in this sort of connection. I went into the elementary schools for the first time since I left them, full of ambitious notions about young children learning science, and I began to come up against the reality of children. This turned out to be more interesting to me in some ways than science, but maybe I've been corrupted by the young; I don't know.

I don't want to talk about the whole of the cognitive process which is obviousl a very complex business and has many phases and many stages. Clearly, at different ages we learn in somewhat different styles. The things I will talk about today are over a fair range already, from pre-school through ten-or-eleve year-old kids, some of whom are practically adults. That is a wide range and I don't want to over-generalize or extrapolate. Therefore, I want to keep my remarks pretty much anecdotal.

I have been impressed by the fact, as I see it, that our educational system traditionally has taken certain kinds of things for granted as coming from the native equipment of the human child. But to my shock and horror, I'm beginning more and more to understand that these things are not there, or are not uniformly there, or are extremely variable at the degrees to which they are there. When you presuppose that kids have certain kinds of equipment in place, and they don't, you make dreadful errors. I think this has always been true. One of the problems I have had is to try to understand why schools have traditionally neglected the fundamental learning that seems to be of crucial importance. The only explanation I can give--and I think it's historically not a bad one--is that in the past the schools have been sufficiently selective and tended to accept as scholars those who did have in place that necessary pre-school learning--that necessary very massive acquisition of tools. Those who didn't have them in place simply didn't go on through school.

There is enough correlation between economic and social advantage and the probability of acquisition of these essential pre-school learnings so that the more aristocratic society was not brought face to face with some of the problems that I think we are brought face to face with. Therefore, they could operate on a more superficial basis and do so successfully. I want to talk specifically about the business that is sometimes called concept formation, conceptualization, the evolution of ideas if you wish; and I want to illustrate this with a few examples. One example: Mr. Phillips, this morning, spoke about compensatory education and said what is in some sense correct: that children from economically disadvantaged areas have more lack, need more help in getting on to the pathway. One shouldn't conclude, however, that children from economically advantaged situations are not deprived or handicapped, because they often are.

The children of the great American middle class today seem to be deprived in many areas of experience quite essential to education. In a middle class professional suburb of Massachusetts (Boston), a classroom full of sixth-grade children were asked to say where the shadow of a stick would fall on their desks when the light was turned on. Not one of them could predict successfully, by marking on a piece of paper, where the shadow of the tip of the stick was going to hit the table. Not one out of thirty-some-odd kids! They all had learned out of the book the proposition, "Light travels in straight lines." The juxtaposition of their uniform ability to pass the test which asks, "What does light travel in?" and their inability to show where the shadow would fall struck me as being an extremely synoptic kind of example where some kind of learning failure that is very radical, very deep, has occurred. If you don't believe this, try it. I wouldn't want to try it on a group of state science supervisors, but try it in a group of your innocent adult friends and see how many of them can actually locate, in advance, the point at which the shadow is going to land on a surface, I dare say that everyone of you believes that everybody can do this; don't you? Maybe you don't; maybe I'm the innocent one who thought this because I hadn't had any experience.

Now, what is involved there? If you think about it, first of all the fact that light travels at all is a very dubious proposition. But you have to say something, so maybe it's all right. Probably the word travel doesn't mean anything very much, except that it is a verb that you stick in the sentence because you have to have a verb. There is a conceptual background for this which is the notion of the light ray, which is indeed very sophisticated. Historically, it only came to definition (this notion of light traveling a straight line) with the Arabs in the Eleventh century or so. The Greeks thought of light as that which rolls away the darkness, and they thought of vision in terms of the eye reaching out to the surface of the object to be perceived. This is an opinion which I find is still very common among all of us. Moreover, it has some essential truth in it from the point of view of the operation of the feedback mechanism of vision. There is a model in the back of one's mind when one does know automatically how to predict optical pathways. If you introduce mirrors, you'll drop a fair percentage of thosewho could predict where a shadow will fall. They will be utterly disoriented as soon as you put a mirror into the picture.

Mirror vision is another topic where, if you actually probe, you will find that very few adults and even fewer children have any automatic initiatory grasp of the habit of this kind of phenomenon. They may know the propositions, but they will not be able to employ them as intellectual tools in analyzing concrete situations. The model in back of this, of course, is a geometrical one. One lacks the model unless he has worked with stretched strings, has been involved in the sorting out of massive, ordinary, everyday experiences, and has paid attention to the formation of images of straight lines. The model is such a terribly simple thing. Everybody knows what a straight line is, but how many use this as a conceptual tool?

So when I talk about concept formation, I'm talking not about the acquisition of verbal structures transmitted from a source of verbalization known as a teacher or anyone else. I'm talking about the preparation of a scheme of analysis built into the working apparatus of the human being so that he can confront his environment competently. Learning in this sense is a complex business which, by and large, we have notrecognized as part of the curriculum. We have assumed that it's already there. It is already there with some children, and with others, it is not. Some of these children we call bright and some we call dull. Possibly the judgment that they are fast or slow is simply a description of how much of this kind of apparatus they have in place. How much of this description has to do with some more congenital difference among them? I, for one, don't know and I don't think anybody knows. At any rate, let me give you two or three other examples just to vary the circumstances.

Batteries and bulbs are a fine topic. Usually a child is led by the nose through a sequence of chapters, or maybe through a sequence of experiments with hardware. I don't think there is any magic in laboratory orientation by itself. You can lead children just as blindly through laboratory exercises as you can through textbooks. There is more chance, perhaps, that they will deviate; that you won't lead them, because there is more opportunity for them to goof off and do something on their own. To me, there is no magic in the laboratory, per se. If you turn kids loose with batteries, wire, bulbs, and with a mild challenge, as "Can you light this bulb?", you will very commonly find out of a class of 32 that not one child can do this. Then you will find a mean time of acquisition of this priceless ability of about a half an hour. Try it again with a random collection of adults and see how long it takes them.

I can tell one story on my own daughter, who doesn't mind. She got A's in high school physics, a college-placement course. The laboratory wasn't adequate, but they tried. She didn't quite get advanced credit, but she did, locally, get an A. Several years later, I noticed that she had put the holder of an electric tooth brush into the charger upside down. I said, "Julie, which end do you think goes into the charger?" She looked at it and said, "Well, this, I guess, because it has the hole in it." By this time I had learned that my verbalization wouldn't improve matters any, so the next day I brought a paper bag with cells and wires and miscellaneous junk that we had been working with in school and gave it to her. I said, "Here." She looked at me and grinned and said, "What am I supposed to do?" I said, "I don't know; light a bulb." At one point the wire got from the bottom of the cell to the top of the cell and she was holding it in her hand, and she suddenly started, "Hey, it's getting hot." I said, "Yeah." A question, "Is that what they call a circuit?" Answer: "Well, sounds like a good word for it, something is going on." Then, after dissecting a bulb and looking inside the bulb, "Ah." And that was the moment of truth, you know. She walked over and connected everything just right and the bulb lighted.

I've seen the same thing with kids, and I see no difference between adults and children. What is essential is the scheme, the concept. That is the difference, not age. You see, the idea is so rudimentary that most of us think everybody knows it, but the mere fact that you know how to put batteries in a flashlight doesn't guarantee this at all. Is it, perhaps, that pathway, that circuit; is that all it is? Is it just the idea of the cycle? It is just the same sort of rudimentary intellectual scheme that people have when they talk about the water coming from the ocean onto land and back to the ocean? Do any of you happen to remember, the great excitement when you realized the significance of this process of circular flow? As a graduate student, I saw it again in economics, and you know historically that wasn't visible to any human being until the time of Quesney in the Eighteenth Century. Nobody had ever described an economic system in terms of circular flow until that time, as far as one knows. These are very rudimentary concepts, and you can tell them until you are blue in the face; but they do not become capacities, tools, powers, or schemes in the minds of the learner, until suddenly some light dawns. This is a very deep process. This is not a simple thing.

I know one educational psychologist who said that the most efficient way of teaching concepts is by telling. I just shriveled up inside because I had seen so many of these examples of people being "told" concepts and being able to "tell" them back with zero intellectual power resulting.

Another example: center of gravity, a very simple notion. Did you ever build up a block structure in such a way that you could hold it so as not to reveal whether or not it was stable, and then ask somebody to predict whether or not it would fall over when you let go? How many people can do this? If you make it complicated enough, none of us could do it very well just by eye. But how many people would say, "I'm not sure but I know how to find out."? How many people would even start making a few geometrical drawings of the centers of the blocks and beginning this marvelous analytical simplification process which finally leads you to a very firm and sure answer? You say, "Yes, it will stand up, let go of it." You know it's going to stand up unless somebody cheats by putting lead in one side of one of the blocks. Many people know the definition for center of gravity, but very few people have the operating skill to analyze a structure. If you had a box of tinker toys here, I would challenge all of you to build a two-dimensional structure that will sit on a single point and not fall over when you let go. I know you know the principles, but if you're like me, it was one thing to know those principles and another to have them enough in your eyes and your hands to be able to just go ahead and do it. And when it doesn't balance but insists on skewing way over in one direction, where are you going to put the extra weight to make it right itself?

Just the fact that it is two-dimensional makes it hard; you know it's not the stereotype of the Archimedes thing sitting on that little triangular point that is always shown in the textbook and labeled "fulcrum." It won't stand up; it always falls over if you really make one.

One more concept, and for this I have a little illustration because it is not quite such a familiar one. First of all, it is a genuine sample from some elementary school work; and second, it illustrates a principle which I think is terribly important in the business of concept formation. It's an analogy, if you wish; but before I talk about it, let's illustrate. The general instructions that go with the package of drinking straws and pins is simply this: "Build something." If the atmosphere is right, you get a great variety of structures; and I have two here to show you. One is rather elegant and economical; the other, rather casual and even sloppy. But the second has a special virtue which some of my associates have exploited in the classroom.

The superiority of the second structure is that you can make many scissor cuts in it before it gets any shorter. This is a property which has come to be called, in the current lingo of information theory, redundancy. No single straw is essential. Each job that might be done by a single straw is shared by many. This is, of course, very wasteful and inefficient unless you want to have a stable, sturdy tower that will survive many vicissitudes. If you really designed a regional power system on these lines, you would have none of these recent power failures that start with a single circuit breaker somewhere!

I think that the only theoretical principle I know that gives me a kind of a platform from which to talk about the development of operative conceptual content is the principle of redundancy that children and human beings acquire: powerful tools of thought through many passages of experience which criss-cross the same area many times in many ways. The biggest failure comes because we don't allow in the basic experiential phase of learning; we don't allow for the acquisition of the part of the child of enough redundancy. We show him something once and expect him to remember it. We see him acquire an insight once, and we think he has it permanently. This, somehow, is wrong; and it is wrong for the reasons in which I hope, in some analogical way, my two structures illustrate. The center of gravity, for example, is a powerful tool of analysis of a complex mechanical structure. It's not the only one you need, but it is one you have a hard time getting along without when you have to simplify for analytical purposes. Where does this notion come from, in the experience of a person who uses it with assurance and uses it meaningfully? It's not verbalization! The verbalization is easily acquired and will only operate in a predominately verbal context of discussion (and even then not very effectively) if it is tied to the early, deeper, and richer roots of primary experience.

The old-fashioned nineteenth century psychologist, Herbart, has a term which I think is very useful, though out of fashion. He talked about apperceptive mass, apperceptive background. Think of the child working with relatively new materials, not instructed to work toward any fixed goal defined by somebody other than the child, but rather involving his own patterns of work and play. In his behavior and the language of his behavior, you begin to see and read what operative concepts he has, and you begin to notice the ones he doesn't have. Coming slowly out of this phase of work (which there is very little of in our schools), you begin to see the child involving for himself some of the bases of adequate conceptionalization. Then, of course, the teacher's art becomes crucial, because if he is left by himself in the style of the old permissive pattern of education, the child doesn't go on learning. The teacher must know what to put in the path of the particular child, based on his analysis of what the child does and how he does it. Put things in his way that make it much more probable that he will begin to acquire certain kinds of conceptional apparatus. This would generally not be the case if he merely continued on his own, as urged by the permissive school of thought which says, "Just give children things to work with and everything will turn out all right." I think a lot of practitioners who talk this way often do give a lot more guidance and impose far more structure than they themselves are aware of.

The people who are really permissive typically create situations in classrooms where you get the phenomenon which my wife calls gadfly, meaning the fly that gads about. The child who sips here and sips there and tastes here; tries that and never settles down to anything--is really bored, although he is always active. He is bored because he is not experiencing the growth of his own power, not having the emotional experience that ties him to the interest in learning. Without growth, the constant savoring of novelties becomes, itself, a bore. So, I am not arguing for universal permissiveness; I am not advocating laissez-faire. But there is a beginning phase in which we rush children much too fast into heavily programed work. If we really slow down; if we give children materials to learn from; if we let them work in their own way, we can see the roots of conceptionalization growing and can treat them accordingly. We can read from that behavior where there are strengths and where there are weaknesses.

Having said that I thought middle class children are culturally deprived in some areas--and I do believe they are, predominately in our country at the present time--I would also like to add that I do not believe the sociologist's descriptions of slum children. These children seem, in fact, to have very many complementary strengths which are not intellectual in the everyday sense, but pre-intellectual strengths of a very substantial kind. I think one has to work with kids of this sort to realize how very much they are capable of bringing to the learning experience in curriculums which don't alienate them. I don't think the correct description of the "underprivileged" has been given in the literature. But that's just an aside. I think differences are more complex between the middle class or upper class children and the slum children than just to say that one has and the other has not. There are deprivations in both cases, and there are things present, in both cases, which are potentially very advantageous.

This concern for concept evolution leads me to emphasize the massive experiential basis of meaningful thought. It leads me to hope that persons who are doing science in elementary schools won't feel this pressure to march on to more advanced topics; to display verbal facilities on the part of the children; to use big words; to prize only the child who uses calculus at the age of twelve. Rather, I hope they will see that the early paths of all learning are slow and indirect.

There must be, in the early phase, a massive redundance of experience and trial and of constructive effort before the child has at hand the raw material from which he can build the powerful intellectual tools that come along later. I think we are in danger of robbing children of these preconditions of learning in our eagerness to produce more knowledge in children. Perhaps one way of avoiding this error (if it is, as I see it, an error) is to shift the emphasis in science education away from the very necessary aspects of what we are trying to end with; namely, adults who have intellectual skills and technical skills that will fit them to be working and operating members of society--and to emphasize in addition something that is very seldom spoken of. This is what I would call the esthetic part of education, the esthetic reward intrinsic to working with good materials in a rich environment where there is no goal beyond today for the child. This esthetic reward is not primarily motivated by the desire to cover a subject matter or acquire a level of efficiency in standardized tests. But the goal should be that which aims to bring about a coupling between the child and the world around him that has for him a satisfying richness. I think the connection of the word "science" with the word "art" or with the word "esthetic" needs to be looked at from this point of view.

People talk about creativeness in science being irrelevant to artistic creation and so on. I think one can bring children to a point where they genuinely enjoy the exercise of those skills they have acquired in work with the concrete and the abstract materials that are available to them. I think we should regard this enjoyment, which is always manifest or at least hard to hide, as the surest indicator of the acquisition of that kind of apperceptive background which seems to me to be the thing that we are in danger of missing.

When I look at the new science curriculum materials for which I have been myself in part responsible (I am not criticizing anybody more than myself), it seems to me that the characteristic of much of this elementary school material is that it is still motivated by the desire to lead the child by the nose down a set curricular path toward a preconceived goal. There is a confusion built into this because it is assumed that the child will be so led, and you end up by inventing the child that goes with the curriculum you have invented; because the real child doesn't follow your pathway. He's stubborn, he wanders off into new things; and if he starts to wander off to other things, what are you going to do? You say, "Sorry, chum, this is our daily visit, our lesson for today, we have got to go this way." The crucial and the absolutely sacred thing you are losing--if you do too much of this--is the child's own commitment to pursue education.

It seems to me that much of the curricular material I have seen is such that is provides the illusion to the teacher and to the child that there is a single pathway along in which you must go if you are to learn. This is, first of all, absolutely false. Even in the final adult formulation of scientific theory there is no unique logical order in which things have to be presented. The notion of unique logical order is an invention of those who write treatises and textbooks. This is not in the nature of things. The evidence is that you can write several treatises on the same subject in different logical order. You can debate afterwards about the merits of one or the merits of another.

Symbolically speaking, the connections among concepts that define what we call theories are much richer than you can represent in a one-dimensional order. Ideas are cross-connected so that you can start with Newton's first law or you can start with Newton's second law, with advantages to each way of approaching it. If you want to study the pendulum, you may think that the proper order in which to study is to put up the simple pendulum first and then study the compound pendulum afterwards; but it may be that that is quite wrong under some circumstances. The best order in which to study is often the most complicated thing first and then on to the simple. When you study the simple things first, you have a tool for analyzing the complex. When you study the complex first, you have a motivation for understanding the simple. Which one of these factors is more crucial in learning is very much a function of the individual's own past experience and his own style of operation. So the final emphasis that comes out of this sort of consideration is, to me, the great need for diversity in style; the great need for diversity in the classroom; the great need for maximizing learning but allowing greater variance--not in the rate at which the children go along a preset path that you've made up, but in the kinds of paths available.

Programmers often urge that the virtue of programed learning is that different kids can go at different rates; but is there any provision for them to learn in different styles? If so, this means you have constructed many, many programs. What I want to say is that we already have the master program at our disposal; it's known as nature.

The world itself is the final programed text and the final teacher. But it's not really like a book or even an encyclopedia. It's far richer in possibilities of learning than such a metaphor allows. It allows every human being to learn by evolving his own patterns through it, in his own personal style.

We need this variance because, in order to optimize the rate of acquisition of understanding and knowledge, we simply have to respect the individual differences, congenital and acquired, up to any particular age. We have to respect these differences as crucial to optimum learning. I think my plea is just that we think hard about the way in which the background information, the background acquisition of intellectual tools, evolves in human beings. We must think of the school as the place where we are trying in every way possible to facilitate this. If necessary, we must be willing to sacrifice certain kinds of order, such as the neat lock-step curriculum, if it turns out that that kind of order does not optimize learning.

I urge that we not be impatient to "produce" knowledge in children at the expense of enjoyment. From the point of view I would take in the analysis of cognitive processes, this sort of enjoyment that I am talking about--where children are involved in subject matter and are exploring it in terms in their own skills and their own capacities--is of the very essence. It is this essence that we are after, because enjoyment of growth is the signal that it is real, that it has happened.

I think that there is probably no name more appropriate to mention in this connection than that of a well-known American philosopher who, if he had been read in connection with the development of practical work in schools and not just turned into slogans, would have had far more influence than, in fact, he had. The name I am referring to is John Dewey whose major book, incidentally has just been reissued as a paperback. It is one of five new Dewey volumes coming off the press, and maybe it means that he will have a renewed vogue. After having some experience in curriculum work now, I find when I read him that it makes far more sense than I used to think it did. It still doesn't make sense easily, because he didn't write English in a way that makes it available to anybody who doesn't really work at it. Many of the kinds of things one hears talked about today as fresh discoveries are clear, already, in Dewey's texts. Much of what we have recently been led to discover is already, at least in part, in Dewey. I don't think Dewey is adequate, but he is by far the best systematic theorist that has written to this day on the problems of education. When we have produced a better theoretical structure than Dewey, then we will know that we have made genuine progress.

## Highlights of the Discussion of Dr. Hawkin's Speech

In the discussion session following Dr. Hawkin's speech, questions about the esthetic value of science and the purpose of teaching science were raised. Dr. Hawkins replied, "I would like to say something about objectives. I didn't want to avoid saying something about that question. Perhaps I was a little too casual in introducing the word "esthetic," but it seems to me that one of the things we want always is a good society, and one of the characteristics of a good society is that it is a happy society. A happy society is a society that is engaged, that is not alienated, that consists of persons who value their lives and value their way of life and enjoy it. We obviously have committed ourselves irreversibly to a way of life that is committed to a great elaboration of technological powers, powers of many kinds. not just physical domain but also in the biological and the social. If we commit ourselves to this and don't enjoy it, we are in trouble, very deep trouble; the kind of trouble that brings historical effort to an end. So, to me, the basic purpose of education in science is to make accessible to children the capacity to enjoy this world that we live in--which is the world of micro-biology and space exploration; a world of enormously complex administrative problems and organizational problems."

In response to a query about the degree to permissiveness that should be allowed in the classroom, Dr. Hawkins said, "The procedure of skillful teachers is much too complex to be described in any such simple way. There are times when a kid is left alone as though the teacher didn't know he was there. Those seem to be times when the child is involved in doing something in which he has some confidence to do. There are times when a teacher moves in on a kid and clearly does not give him options as to what he shall do. What I think is common and the reason this is possible is that most of the class at any one time doesn't need the teacher. Their work is self-propelled. Can you do this with a class of 38? I ask this question of several teachers in England because their classes are forty or more. Their classrooms are quite a bit smaller than we would think we would like with that many kids. Old buildings and the restriction at forty is a legislative matter--you can't hire a new teacher in a school district until you have forty kids without a teacher. That means the average is above forty. The response I got from one teacher (which really set me back on my heels) was, 'When you have forty kids you can't afford not to do this.' Not to individualize, not to diversify, not to get the forty simultaneous juveniles out of your hair. You have got to make them more self-reliant; that is the only way you can keep your sanity. I had always said the opposite. I had always said, 'Yes this is fine to do if you have a class of fifteen, but how can you do it with forty?' I don't think it's good to have that many; in fact, I think there are obvious weaknesses in some of the English programs because the teachers are just plain overloaded and overworked. But they were clearly doing a different kind of job, and by all subjective indications they were doing a much better kind of job than they had been doing under a highly permanentized instructional system.

"How much permissiveness?--this is the teacher's art to know. The idealizing description of a teacher is the teacher as a professional person. The teacher is the ultimate builder of the curriculum with all help and all provisions from the outside and, sometimes, all the advice and moral support. The ultimate authority ought to be in the hands of the teacher. When does Johnny need to feel the investment of adult authority in a subject matter? When does he need to be let alone?"

When asked if the cognitive approach was an outgrowth of the philosophy of John Dewey, Dr. Hawkins replied, "I always want to disagree with Dewey--I mean I don't read him easily. I don't like the way he says things. I find him a tough character to cope with, but I have begun to get a little bit of intuition about teaching and learning which I didn't have before when I read him as a philosophy student. I find now that he is much more to the point than I thought he was then. I don't think he is a model for a guide. I do think he was a man born before his time, because it seems to me quite clear (with a few impressive exceptions) that most of the school conditions that came from that movement were not a kind of thing that we are aiming to do now. I think the school tradition tended not to realize that to run classes in the way they theoretically were proposing to run them requires an enormous amount of discipline on the part of those who are running them. The enormous accumulation of ideas, materials and resources (material resources and natural resources), and the lack of this discipline will cause us to get flabby. Lacking that, you get the stereotype phenomenon of the permissive school."

Dr. Hawkins was asked if there was any danger in blocking a student's total progress by attacking more complex problems before the simple, and if there was any research on proceeding from complex to simple. He answered, "About the complex and the simple. I don't know of any research; if I do I can't think of it. There is nothing that stands out. If I say that a child is studying complicated combinations of pendulums, he's really not studying this in the manner of a physicist who is writing down the simultaneous differential equations for all the degrees of freedom in the system. What he is doing may be any one of several things. For example, he may be building a new kind of mobile which he's discovered."

He went on to say, "I am going to look at a single pendulum. In other words, he discovers something terribly important which is, at the point of view analysis, to disentangle the complex so you can go back to the simple. This is the method that Galileo first seriously proposed. It's not trivial; it's not obvious; it's not easy. Disentangling the variables is certainly one of the major accomplishments--I mean learning that you have to disentangle the variables and control them and so on. When a kid does that you know he is in, don't you? You see some guy say, 'I've got three variables, I must hold these two constant.' You say, 'Well, I don't have any more to teach him about this aspect of the investigatory processes; he's got it and where he got it I don't know.' Those kids who don't have it, you can show them; you can control the variable for them; which is what you do, and you produce radically simplified materials. Nothing can change except in one dimension. Then he will get his results all right, but he won't learn how to disentangle variables which is far more important to the scientific art than making observations after you have disentangled them. So, the complex and the simple come together. I wouldn't want to put one of them ahead of the other. Pre-analytic, the complex is often esthetically more interesting than the simple. Unless you are interested in the narrative, why do you want to look at equalized and balanced sticks with only one weight on each end? If you are not analytically minded, or unless you want to weigh something with it, why do you want to look at that rather than a big long stick with fifteen different things hanging on it? It is much more fun. Then you can still make it balance and that's still pretty exciting; and the intuitions you will carry away from that will feed and motivate your study of the simpler things. I don't know how to establish this; I don't know how you would do research on it.

Don't we all sort of know that that historical order of coming to understand something is not the same as the logical order in which you put it after you understand it? You put it in the logical order from the simple to complex after you understand it. That is post-analytic, but pre-analytic you follow the tracks which your own readiness leads you to want to follow."

Finally, in answer to a question about problems of evaluation, Dr. Hawkins discussed some of his observations in English schools.

"I like very much some of the things I saw them doing which tended in the direction which I obviously have been advocating. But in the course of this, I was talking to a teacher in a school about her work, and she was quite enthusiastic about it and said she would never go back to doing things the old way. It was clear that the whole class had been reorganized; her whole room had been reorganized. It had gotten arranged so she couldn't lecture to the whole class at one time if she wanted to, because there were so many corners, so many book cases that had been turned out to divide a little corner where somebody could work in the class. Moreover, science seemed to have taken an inordinately large part of her total time. In fact, she was devoting all afternoon every afternoon to it. I said, 'Well, you know, what about other things?' 'Well,' she said, 'Well, I don't have any fun in the reading program anymore, so I dispensed with that.' I said, 'Oh'. 'Oh, yes,' she said. I said, 'How are your children doing?' 'Oh, they are learning to read.'

I noticed that there were a lot of books in the room and the children were frequently seen reading them. There were science books and other books too, and this seemed to be the reading component of instruction. Maybe the children were motivated to read books, and, therefore, learned to read. But I was being a typical American at this point and said, 'Well, have you evidence that this is going on in several of these schools?' 'Oh, our children do at least as well.' Well, I said, 'Where are the scores on the reading tests?' She said, 'Oh, they are some place in the files.' She couldn't care less. Then I got American and I said, 'Well, what are the statistics?' English don't seem to care much about statistics. Finally, she got a bit annoyed with me for wanting to see the statistical proof, and she said, 'You know, to me, a child has a good day every day in school, would I think that that might be sufficient.' Maybe I would. It even sounds greatly Christian, doesn't it?"

# SCIENCE--A PROCESS APPROACH

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To consider our subject, I would like to suggest, first, that Science--A Process Approach is a sequence of instruction in science for the elementary school developed by the Commission on Science Education for the American Association for the Advancement of Science (AAAS) under grants from the National Science Foundation. For the convenience of our thinking, I would like for you to consider three words: Science, Process, and Approach.

Particularly, I would like for us to ask ourselves: What is Science? It is a very academic question and I'm sure you have heard this many times. I heard a definition at the New York Meeting of the National Science Teachers Association (NSTA) that I liked very much. "Science is the belief of the ignorance of the experts." The importance of this definition is that when you think of science in this context, it is nothing more than checking up on the one who should know what he's talking about.

Now, how do you check up on Science? What is the stuff on which you are going to check? I suppose that the best technique that we have for checking up on science is the experiment. Another way of saying this is that the experiment is the most elegant tool by which we can gather knowledge. The basic step by which we gather knowledge is observing. After all, one would suspect that there are few Nobel Prize winners in this group. There is a difference between you, me and a Nobel Prize winner. Primarily, it comes back to the fact that the Nobel Prize winner is able to see something quite unusual in something that was very usual. We haven't gotten to the point of being able to see that unusualness about the usual. If you look at a Nobel Prize winner, most of them have some hair on the top of their head, two eyes, two legs, and many of these characteristics are very similar to us. Isn't it rewarding to you to know that you are similar to a Nobel Prize winner? In some aspects you are. The difference is that they were able to see the unusual in the usual. They also had some ways of operating, some ways of doing experimenting to gather empirical evidence which we have not yet obtained.

To extend our thinking about Science, consider a sheet of paper. Suppose you write down all that you can regarding the sheet of paper. If you will look at what you have written down, there will be a great variety among your responses. You can code your responses in this way. Put a numeral "1" by those responses which you used your eyes to make. Put a numeral "2" by each of the responses which required you to use your nose. Put a numeral "3" by each response that required you to feel. Put a numeral "4" by each response which required you to taste. Put a numeral "5" beside each response that required you to listen.

Now put a numeral "6" beside each response that was a quantitative observation. What do we mean by a quantitative observation? It is an observation indicating a measurement of some kind. There is a distinction here between those observations where you make just a comparison and in those where you make a specific measurement; that is, you make a comparison against a standard and express the result with a number which answers the question *how many.* Put a numeral "7" beside each of your responses which were inferences. For example, was the response that perfume had been poured on the paper an inference? Did you see perfume being poured on the paper? The odor was an inferred observation in that this is a point where you extended beyond what you actually saw to an explanation that was useful in interpreting what you were observing through your sense of smell. It is possible for you to see perfume being poured on the paper. You could infer this by either looking at the stain on the paper or smelling the odor of the paper.

At this point I would like to suggest that you are doing some things which are related to science. You are using ways of extending or organizing our *observations* in which you have taken the stuff that has been right in front of us and about which you could gather information through your five senses.

We also have indicated ways to extend observations through *inferences.* It is possible to get to the point with our direct observations that we no longer can distinguish the differences between them. At this point we need to have tools by which we can distinguish between objects, such as comparing lengths or mass or volume. Thus, we are *measuring*. We also are able to extend our observations through using basic descriptions of where-we-are or where-we-are-when, another way of defining *space and time relationships*. We extend our observations by *using numbers*, to specify how many or how much.

We further can extend our observations by making statements of expectations, or making *predictions*. It is interesting to note that a prediction can be made by an individual who does not understand at all or can explain the event that he is predicting. For example, you do not have to understand or explain why the candle goes out in a jar. If after several experiences, you have been able to identify the burning time of the candle within various size jars, you can predict that the flame would go out within a certain time. Incidentally, this is one thing that we, in the AAAS program, feel very strongly about. Explanations in the classroom are only appropriate where there are adequate student experiences. It is inappropriate, we feel, to talk about the candle's going out because of the condition of the air inside the jar until the student had a tool by which he can identify and verify that,indeed, the air does change. So, initially when the students are working with the candles at about the third grade, the emphasis is not on *why* the candle is going out. Later on in the sixth grade, the student becomes acquainted with tools by which he can identify the composition of the air: the role of carbon dioxide and its identification. Then it is possible for him to bring these competencies to bear on explaining why the candle goes out.

An additional way in which we can extend our observing is to classify. In classifying, we take the similarities and differences of objects and look for those similarities that groups of objects share. This, indeed, becomes a very useful scheme by which we can group and interpret our environment. It is an amazing thing to watch children separate things and tell you the basis for separating them that way. One time when we were doing this, the children had nine animals in the classroom. One of the children had grouped them together. He took a parakeet, a hamster, and a turtle and grouped them together. You know that a turtle and a hamster and a parakeet belong to the same group, don't you! This boy did and his reason for grouping them was that they all had toe nails. Classifying can be a very arbitrary thing. It is man-made; it is not inspired. It's the way we and our human ingenuity have created schemes by which to classify objects. Any classification seems perfectly satisfactory as long as it is useful.

Note that we are not yet ready to conduct an experiment. In the AAAS program we have been discussing thus far, we have been looking at the several processes or basic tools which are emphasized in the early years. These tools, as we have discussed them, include: observing, using space/time relationships, using number relationships, measuring, communicating, classifying, inferring, and predicting.

In grade four, the integrated processes are introduced. One of these processes is that of formulating models. Model is defined by AAAS as a mental model--an idea, and in using this model we make physical representations of it. The idea, many times, comes out of our attempt to classify and to select those relationships in our classification scheme which we feel are important. Those that we wish to ignore in effect also distort and, when we are representing our model, result in its distortion. You know a map is a distortion. However, this really distressed children in one fifth grade class this past year. They felt that if the map was in the classroom it's "gotta be right." They refused to admit that a map on a classroom wall could be a distortion, that it could be wrong! In this particular exercise, the teacher started off the lesson by taking an orange and cutting it in half. Then, in front of the class, she ate half of the orange. Then she put a newspaper on the floor and the shell of the half orange on the newspaper and stepped on it--squashed it out. Now the children had an opportunity to look at and discuss what distortions happen when you take a half sphere and flatten it. I would like to point out that the process approach is designed so that experience for the label comes before, not after the label. You know it has been said that Adam saw the animals before he named them. In Science--A Process Approach, students are expected to use a label after an experience, and, I should add, not just an experience, but a variety of experiences in a variety of situations.

Another integrated process is Manipulating Variables. This is a situation in which students learn specific skills in permitting one variable at a time to change and identify proper instruments to measure or observe the responding variable or variables.

Making Operational Definitions is a third of the integrated processes. An operational definition tells you what to do, how to distinguish, or how to measure. The children in one exercise end up by making an operational definition of the camera. To do this, the students identified the essential characteristics of a camera that had to be included in the definition. What things must one have in order to call it a camera? Then, how can one describe these things so that only those things that we want to call a camera will fit?

Another of the integrated processes is Formulating Hypotheses. A hypothesis represents an extension of an inference beyond the specific situation to include a generalized statement that applies to all possible instances of that situation.

Interpreting Data is another integrated process in which students learn to take the data that they have collected and look for relationships in it, and reasonable interpretations of the data. One of the most exciting activities of the program is the one which deals with the chick embryo. In this, the children put a series of eggs in the incubator for different periods of days. On the eighteenth day, the eggs are removed from the incubator and the embryos separated. This results in their observing embryo developments from the fifth day to the eighteenth. day. Now to interpret this data means that the students would have to take all the evidence they can find, including encyclopedias, and descriptions of what a five-day-old embryo looks like and line it up with the ones that they know are five days old, to see how these embryos compare with the typical characteristics. Within this exercise, there are many things which are disturbing to students. You see, we have yet to find a five-day-old embryo in Austin that looked like what the encyclopedia said was a typical five-day-old embryo. There are many kinds of variations. This is an opportunity for students to say, "All right, what this encyclopedia means is that that diagram is atypical and that either the characteristics may be present or may not be present in the individual five-day-old embryo."

At this point, may we suggest that students are getting to the stage in development where they are ready to identify a question they want to look at, to describe the procedures that can be used to gather evidence concerning the problem and then to gather data, and to interpret that data in the light of their experience for reasonable conclusions. This is experimenting--a process which is emphasized in the intermediate grades.

Before our leaving for the classroom demonstrations, I would like to suggest three points about this approach to science in terms of instruction.

First, in this way of teaching, as I am sure you will see in the demonstrations today, it is not important what teachers can get across to students. What is most important is what the student can get across to the teacher.

Second: For experiences to be meaningful to children, they must have not just one experience, but many, and these many experiences in a variety of situations with a variety of materials. So, after a student has learned to interpret data of chick embryos, we do not say that these students are qualified data interpreters. They need to meet data interpretation in a variety of situations that range from rolling cylinders to bouncing balls to chick embryos to growing plants.

Third: Telling is for time and not teaching. What I mean by this is what Gibran said, "If we indeed would be wise, we do not lead people to the house of our wisdom, but rather we lead them to the threshold of their own mind." Teachers of Science--A Process Approach find themselves not as individuals who have all the facts and information to pour into little students' heads. Rather, they are people whose job it is to lead each one of their students to the threshold of that student's mind.

## Highlights of the Discussion of Dr. Butts' Speech

After observing AAAS classes in session, the participants discussed the program with Dr. Butts. The following statements by Dr. Butts are highlights of that discussion:

"Many of your questions dealt with the inservice preparation of teachers--how to go about doing it. I am the last person in the world to say that we have an answer to give to you; come to Austin and find out. I will suggest, however, that we've been working three years on this problem with about 260 teachers who have written an inservice program which they feel is meaningful. This isn't usually the best inservice, I know, but what we have been doing for three years is to work with a series of activities the teachers say they would have found helpful at the end of the year if we had a way of turning the clock back to August and saying, 'All right, now what do you wish you would have done before you started this year?' So the program that the teachers are following here this week represents the efforts of 260 teachers in writing in-service programs. The curriculum dissemination network for the State of Texas which is being funded under Title III, ESEA, is planning a series of not less than twelve, and probably closer to fifteen, in-service training centers in the state.

The operation of these in-service training centers will be where we will have experienced classroom teachers, not science specialists. These people will have the responsibility of working with teachers in the entire county, not just Austin. These teachers will come here to Lucy Reed school for ten half-days of in-service training during this coming school year. The budget of the center will provide for the substitutes to take these teachers' places in their classroom when they come out here for in-service. You see, I have a little bit of a feeling down in the bottom of my stomach that it's a little bit of an imposition to ask a teacher to go to in-service at four in the afternoon. She has other responsibilities. Most of them are women; they have families; they have responsibilities at home; and bless you, after you've stood on your feet for eight hours during the daytime, you're not ready to go to a place to be intellectually creative. At least, if you are, you're an exceptional individual. So, the in-service program is coming during the school day. The first four meetings for these people will be one week apart. Then suppose that I'm a second grade teacher out here in the boondocks north of Austin. On Tuesday afternoon, I'm scheduled out here at Lucy Reed. I and nine other second grade teachers will come here for a meeting on Tuesday afternoon and I'll come for four Tuesday afternoons in a row. While I'm here at Reed, a substitute's taking care of my class back at the school. What am I doing here at Reed? Mrs. Wilson will be working with me. We'll be going down here to a second grade classroom where Mrs. Wilson will be teaching a complete classroom of children--not twenty-two. Twenty-two is because of the summer program. It's not possible for us to have the full group. Now while Mrs. Wilson is working with us, we have an opportunity to see someone teaching a program; we have an opportunity to ask her questions about what she was doing and why; we have an opportunity to look at some of the content background sections that are designed for the teachers to train them in the background of what they're doing. Then I have a job of planning a teaching exercise this coming week in my class. So I check the kit of equipment out from the center and take it back with me to my class and between now and next Tuesday afternoon I'll teach that exercise or as much of it as I can. My children don't ask the kind of questions that the book said they'd ask. So I come back next week to ask Mrs. Wilson why. Now after the first four of these sessions, the other six sessions will be about a month apart. We're doing this because we've found that it's necessary for us to keep constant contact with that teacher throughout the first six months or so. We get all enthused at the 'revival meeting' but pretty soon we lose enthusiasm. After the evangelist has gone, we have a way of just sort of dying down and facing the reality of 37 kids in the classroom.

We're exploring the idea here in Texas of doing in-service teacher training in this kind of a way where we have a center with two teachers. And it looks like, in our estimation, we can train 250 teachers in a year's time. We can schedule that many people for a full in-service training program in a single center. If we add a third teacher to the group, then we can multiply a little more than that and probably get close to 500 teachers that we can put in and out of this center in one school year's time. The whole idea behind this is the fact that surrounding Austin are seventeen school districts which have less than twenty teachers in the school district. These are school districts who do not have in-service training programs for the teachers. If it were not for this kind of center, these people would have no opportunity for in-service training. Do we use ETV (Educational Television)? There's an interesting question. Four years ago I had the privilege of teaching sixth-grade science on the ETV station here and in central Texas and an opportunity of watching the reaction of children to this. I would suggest this. Frankly, there is one key thing that I think must be involved. That is, in the in-service training of teachers, if we're training teachers to have students as active participants, we've got to have teachers as active participants. Now if we can design an ETV program where teachers are active participants, then I'd say fine. It's a very useful thing to explore.

How much time for science? The answer to this question we've been following in the State of Texas is the same amount of time for science this year as you used last year. If you teach science fifteen minutes a day in your class, fine; you teach science fifteen minutes a day in your class this year. Do not ask for any more time. Now you say: 'But, wait a minute! Are the teachers following this?' No, they are not. Why? Because last year, they didn't teach any science at all. They put up a bulletin board and that was all. And, we're finding that, indeed, teachers are spending some time on science and they feel it's very worthwhile. You know, my very candid opinion is you don't make a teacher do something. You give her the regulations so she has to, but she'll find a way of getting around it if she just wants to.

Compare the experienced and non-experienced child. This question, I gathered, is asking, 'How does the child look in the fifth grade, how is he different if he's been in AAAS for three years as compared to a fifth-grader who has had no AAAS?' We've had some experience here in Austin on that. Right now we have a population of 88 children who have been in the AAAS program for a continuous period of three years. Out of our initial ten classrooms for children that we started with in 1963, we still have 88 children in Austin. I think the best answer I could give is by telling what happened with one fifth-grade teacher at a Latin-American school here in town. She said: 'Dave, I've taught in this school now for seven years.' She teaches the fifth grade and she said: 'In my classroom, a discussion was my yakking at the kids. I couldn't get them to say anything because they'd learned very well to shut their mouths and be polite and nod their heads and say' yes' or 'no ma'am, ' but that's all.' She said this year has been the most amazing year she has ever taught. She happens to have a class of children who have been in AAAS continuously since the third grade, fourth grade and now in her fifth grade class. She said, "I dan't say a word in my class without these kids questioning me and making me go back and give the foundation for what I've been saying. These kids have an independence and their own ability to look at something and think about it and talk about it that I've never experienced before in my life.'

"Well, that's just one bit of evidence that we have. I think I could point to some others. For example, in San Antonio, a principal said that she had had the procedure in her own school of going around and giving a child in the primary grades a pencil if he had been there six weeks without absence. She had difficulty making the rounds of the whole school and not giving away a box of pencils. She started her rounds the last year and the second six weeks she said she gave away two boxes of pencils in two fifth-grade rooms. This never happened in the eleven years of her teaching among schools. I am saying that in this room the kids had enough attraction that they did not want to stay home."

# OUTDOOR SCIENCE EDUCATION

Dr. Matthew Brennan
Director of Field Studies
Pinchot Institute for Conservation Studies

As an ecologist interested in relationships, I find it difficult--no,--impossible, to separate outdoor science education from indoor science education, or from science education anywhere and everywhere. I also find it impossible to separate it from conservation, which is man's recognition of his relationship and interdependence with his environment and with life everywhere; his responsiveness to his position as a species in which he has been placed by biological evolution and cultural evolution; and his responsibility for maintaining an environment fit for living and fit for life. Therefore, I will be talking about each of them and all of them, and our responsibilities to and for them.

We have developed in America the greatest system of education ever conceived by man. This is especially true in science. Yet we know that something is lacking. Or why would we be working on new courses and new methods? Why is the general public lacking in scientific literacy? We give lip service to problem solving and the processes of science and the scientist. Yet we fail to give our students the basic knowledge necessary to recognize the problems we want them to solve. We prescribe what they must observe, and even limit their freedom to fail.

We have new curriculums--although I should call them courses since their place in the total curriculum has not been either planned or determined.

We have new physics courses which overlook the basic physics of life, the recycling of matter and energy in living things.

We have new chemistry which overlooks the chemistry of biocides which may play a vital role in the survival of man and his environment; in the chemical waste products of fuel consumption, carbon dioxide, and the leaded wastes of internal combustion engines which make breathing a hazard in some sections of the world; in the detergents which guarantee a clean, white wash and suds in the drinking water of many Americans.

We have three new biology courses, one of them even being called an ecology course, which ignore the fact that man is a living creature of the laws which have evolved for living things over six billion years and, as of now, the most important single factor in the natural selection of all plants and animal species.

So--what I want to talk about with you is a new science education, for the survival of man as a species on this earth. Despite what you read in the papers and in the publications of NASA, the future of man depends on this space here on earth, not that other space, important as that may be.

Isn't it a little dramatic to speak of science education for survival of man as a living thing on this earth? I think not. Man today has come face to face with the possibility of the total destruction of his environment. Our old methods of dealing with our environment are inadequate. Equilibriums set up over an evolutionary period of six billion years have been upset during man's short existence. How short a time this is was wonderfully and dramatically demonstrated by Dr. Herbert E. Walter in his comparative anatomy classes at Brown University. Walking briskly into the lecture room, he proceeded to unroll a large roll of toilet tissue, keeping hold of the first sheet. Coming to the end, he said, "Gentlemen, if the sheets of paper in this roll represented the ages of the earth, the time man has existed could be represented by the fringe on this first sheet."

During this relatively short period, man has claimed and in many cases seriously jeopardized the future supply of land and resources, both renewable and non-renewable. Now he is invading the inexhaustible resources of air and space. He is multiplying beyond the capacity of the earth to support him.

The problems which give us concern for man's survival as a species, however, are very new--the fringe on a new roll of paper representing man's time on earth--the last twenty years following World War II. I call them the "P" problems: population, pesticides, pollution, pressure on resources, and poverty of the environment.

## POPULATION

We have always considered overpopulation a problem for other nations. Now, we, in America, must face the problem here. We will have a population of 300 million by the year 2,000. Can we maintain the present quality of American life? Do we want to?

David Lilienthal, Chairman of the Development and Resource Corporation, said in a January 9 New York Times Magazine article titled "300 Million Americans Would Be Wrong": An additional 100 million people will undermine our most cherished traditions, erode our public services, and impose a rate of taxation that will make current taxes seem tame.

Whether or not Mr. Lilienthal is overstating the case, only time will tell. But, in our major cities, we have already passed the point of wondering whether the quality of the lives of their inhabitants will withstand any more growth. And, more growth we will have to have. Most of the growth will be in our cities. We can afford it financially. Can we afford it in terms of quality of life?

Will we be able to provide the year 2,000 population with water, air, fuel, and electricity? If we can, will we be able to get rid of the waste products of our growing civilization?

## WATER

We at The Pinchot Institute in Milford, Pennsylvania, have a ringside seat as a great water drama unfolds. The beautiful Delaware River which flows through the valley below us serves as the source of water for many towns and cities along its shores, including Philadelphia. Several of the largest tributary streams above us in New York State are dammed to provide water for New York City. In years of drought, New York City holds its waters. The Delaware drops to a trickle. The lowered Delaware lets the ocean tides come up the Delaware estuary dangerously close to the intake pipes which serve Philadelphia. If they come any further, Philadelphians will drink Atlantic Ocean salt water instead of Delaware River fresh water.

Up to this year, New York has released enough water to keep the Delaware above the danger level for Philadelphia. But would she if New Yorkers were really short of water?

The situation could make the lower Colorado River water quarrels seem like a friendly party. For here, hundreds of millions of people are involved, compared with hundreds of thousands--and the worst is yet to come. Even with normal rainfall in the future, the increased populations will make supplies inadequate.

Oh, yes, we can get water from the sea, but at tremendous cost. We can use atomic powered desalinization plants, but what will we do with the radioactive **wastes**? We won't be able to plant hedges in front of them, as we talk of doing with automobile junk **yards**. We can clean up our rivers, but the costs will be fantastic. Will we want to pay them? Do we really care?

## AIR

The problems of air are similar, though not so readily apparent to the average citizen. Oh, he knows the city is dirty. The air is bad. But cities have always been dirty. In fact, many, like Pittsburgh, which formerly used large amounts of **soft** coal for fuel, look **cleaner today** than they were thirty years ago. I emphasize "look" cleaner. They are not clearner. The air is full of lead particles from automobile exhausts. As the numbers of people increase, the pollution of air will increase. Keeping it clean will cost fantastic amounts of money.

More directly, but probably equally important in the long run is the problem of $CO_2$ in the air. As you know, it is given off by animals as they breathe, and by organic fuels as they burn. Scientists estimate that by the magic year 2,000, there will be 25 per cent more $CO_2$ in the atmosphere than at present. Carbon dioxide produces a kind of "greenhouse effect" on the atmosphere. It forms a heat blanket over the earth, which slows down heat loss to the atmosphere. The predicted 25 per cent increase in $CO_2$ levels will produce marked warming of climates, with resultant changes in the heat balance of the atmosphere, and conceivably, also, marked changes in rainfall patterns over the earth.

Population, then, must be considered as the most important problem facing the future of America, its beauty and its bounty. Every other problem is either caused by or related to population.

Up to very recently, population has been a problem for the other fellow, the Lation American, the Indian, the Chinese, the poor among us. Only recently have we thought very much about population in terms of America's problems--our poor, our underfed, our unwanted children. This is understandable. America's greatness has been based on growth. Our economists base our future on anticipated continuous growth. But growth is based on resources. And even with our present population, we are reaching the point of reduced quality of our environment--poverty of the environment. The best land is gone. In extreme cases like Appalachia, the land has been raped and left. And while we have programs of relief for the people who must still exist on those ravaged lands, new areas are being stripped every day for coal whose value, in terms of the future, might indeed by questioned.

In subtle ways, the poverty of the environment is reaching into our most hallowed natural shrines. Mountain lakes in isolated wilderness lands show trampled shorelines. How many more thousands a day can Yosemite Valley stand and still remain one of America's natural gems? Will we have to invade our natural parks in order to provide water? Land?

Natural areas for wildlife are rapidly reaching what Dr. Brandwein calls "concentration camp" status. Animals will be unable to come out, and people will not be allowed in.

And then there is what I call environmental deprivation. Increasing numbers of humans are living in cities. They spend their lives in a synthetic environment--conditioned air, controlled intensity lighting, soundproof rooms, windows which will not open without destroying the artificial environment.

Temperature changes, sounds, changes in light intensity, length of day and the sight of a magnificent view are stimulants to an animal nervous system. They may be part of the existence of man as an animal. We know that animals deprived of these stimulants have nervous breakdowns or develop ulcers. And man? I have not mentioned radioactive fallout deposited in patterns determined by the circulation of the atmosphere, which, in some areas, has created ecological problems which merit concern, to say the least. So our concern here as science educators, or as leaders, or just as humans, must be man and his environment. Our concern must be environmental science in all its aspects, physics, chemistry, biology, geology.

Our basic assumption is quite simple. If man is the only organism which can consciously transform, manipulate, control, destroy, or wisely use his environment, then an understanding of the environment, and how it can be transformed, manipulated, controlled, destroyed or wisely used should be an essential element of human knowledge. It is not. It is our responsibility to see that it is. For the organism is the product of its heredity and its environment. That is our basic concept.

But even this is not enough, Is it not also necessary that we understand the consequences of any scientific action we undertake which affects the environment? Whose responsibility is it? This is one of the basic decisions scientists and science educators must face. And there is plenty of divergent opinion as to who is responsible for teaching the effects of man's use of his scientific discoveries.

Lord Brian, retiring President of the British Association for the Advancement of Science, directed his address at the 1964 annual meeting in Montreal to dispelling some prejudice against science and scientists--especially the notion that scientists should be held responsible for the applications and consequences of their discoveries. In making their discoveries, he said that scientists are merely fulfilling their nature as human beings. They are usually in no position to foresee their consequences, nor, surely, even if they could, should they be the people to decide whether those consequences were good or bad. These would be judgments of value for which the scientist, as such, is in no way equipped. Maybe the words "as such" are the key to Lord Brian's statement.

But isn't the scientist also a responsible member of the human race--and shouldn't he, indeed, be concerned with the effects of his discoveries? Of course he should! The report of the AAAS Committee on Science in the Promotion of Human Welfare entitled "The Integrity of Science" takes scientists to task for lack of communications between relevant branches of science in the pollution problem.

According to the report, the introduction of synthetic detergents and insecticides into the biosphere represents a serious human intervention into natural processes. The evidence cited shows that this intervention was not based on an orderly, disciplined development of all the requisite basic scientific information. The full biological significance of the large-scale introduction of synthetic detergents and insecticides could have been discovered much sooner if there had been planned systematics studies of their effects on the water supply in small-scale field studies. And then the skeptic might ask, "What difference would it have made?" Rarely are resource-use decisions based on scientific information anyway.

Experience has indicated that conservation decisions need not be scientifically based--in fact they are more apt to fall into one of these categories: economically feasible, socially desirable, politically expedient, or esthetically pleasing. Unfortunately, in the vast majority of cases, we could just say the decision was economically feasible.

It could either be a quick profit, or an excuse for inaction, or a cry of "too costly"--as in the case of cities that refuse to treat their sewage before dumping it into the rivers of the nation, or industries whose waste products overburden our waterways. As a result, it is estimated that, within 15 years, these human and industrial wastes will remove all oxygen from our major rivers during the dry season flow. In space, we do not have the problems of economic feasibility--cost seems to be unimportant. We do not have any politics--everyone is for it, like motherhood. We do not have any questions of social desirability. Our astronauts are heroes.

Those who would provide a sanative environment for man on earth are not so well received or supported. I think we, as science educators, have a responsibility to change all this. We have a responsibility to guarantee that decisions regarding man's use and abuse of his environment are based on scientific knowledge.

This will not involve a narrowly-conceived program of environmental science. If it does, it will meet the same fate as other narrowly-conceived programs--conservation, health, tobacco, and nature study. They never became part of the total curriculum. Just as they were added, they were eliminated. Environmental science must become the base for a total curriculum. It must be integrated into all areas of the existing curriculum at all levels of education.

Isn't it paradoxical that we can send a man to the moon, but we cannot develop a curriculum which will give our citizens the basic understandings, knowledge, and skills to enable them to survive as a species in a changing environment. I don't believe we cannot do this. We can. We must.

Dr. Brandwein and I have recently embarked on this effort for a total curriculum for environmental science in our program at the Pinchot Institute. With our guidance and the financial support of The Belle W. Baruch Foundation, the State of South Carolina has begun such a curriculum development. Eight curriculum guides for all subject areas and levels of education are being developed around basic concepts of conservation. Mr. Albert Dorsey- one of your group of state science supervisors, is directing this project.

I wish I had time to tell you more about this project. Perhaps we will get into it in the question period. Basically, we deal with a concept such as, in science, "The organism is the product of its heredity and its environment." This can be related to individuals, plant or animal, or populations of species, including man. Always the interaction of heredity and environment.

In social studies, this becomes, "The community is the product of its culture (heredity), its laws, and its people (environment)." We believe the development of science concepts for other subject areas will also facilitate the understanding of the basic science concepts.

But curriculum is not enough. In order to have education for the total environment, we must have a total environment for education. Up to now, we have not had this. We have had curriculums and courses which required textbooks, workbooks, libraries, films, filmstrips, television, indoor laboratories of all sorts--but no outdoor laboratories. The same is true of our teachers. They have been trained to use textbooks, workbooks, libraries, films, filmstrips, television, indoor laboratories of all sorts--but not the outdoor laboratory.

If we are going to give our students experiences in search of meaning, which Einstein called science, then we must have outdoor laboratories. Why? Simply because we must strive for efficiency of teaching and learning. We have been inefficient in science education long enough.

Some things can best be learned in the outdoor laboratory. We should go there to learn them if they provide the best experience in search of meaning.

There are some things that can best be learned in the classroom. There are some things which can best be learned through use of a film. For example, you cannot transport all your students to the laboratory at Climax, Colorado, to look at a solar corona. They can look through the solar telescope in the film, "Our Mr. Sun." This can be done in a similar fashion in learning about Antarctica.

For some science, children should go to a museum. For example, a museum is the most efficient place to study the layers of the earth, formation of volcanoes, or prehistoric environments.

The indoor science laboratory is the most efficient place to have many experiences in search of meaning. For example, experiences with electricity or chemical reactions.

Similarly, the outdoors is the most efficient laboratory in which to provide some experiences in search of meaning. For these, it should be used. In most schools it is not. The outdoor laboratory provides the only possibility for research in science. Read, for example, the article in the March, 1965, issue of Science and Children.

New curriculums and new emphasis on outdoor laboratories and supplemental science centers as a result of Title III projects will demand new rules. Why should parental permission be necessary to take children to an outdoor laboratory? Why should teachers need special insurance to cover accidents in another one of the school's laboratory facilities? Why is not equipment for the outdoor laboratory available? I have visited hundreds of schools across this nation with shelves of NDEA purchased laboratory equipment; rarely am I able to find binoculars, soil test kits, soil augers, tree increment borers, hand lenses, or cameras for recording the lessons in the outdoor laboratory.

Let's take a new look at our responsibilities in this new total education in a total environment for a total environment fit for living and for life.

Let us take advantage of the new impetus we will receive from the Title III projects under the Education Act of 1965 and the funds being made available. Many of these will be used for the development of more nearly total environments for education.

Most important, let us not again delude ourselves into thinking that financial support is going to solve our problems. **Remember that!** Let us always remember that the job ahead is curriculum development. In the past we have failed to recognize this fact.

Under the National Science Foundation we trained teachers, in some cases, for non-existent courses. We have spent bundles on new alphabet science courses which neglected their place in the curriculum and failed to gain the usefulness they could have had. AAAS shows promise, at least in this aspect of it. We have science laboratories across the land stocked with NDEA equipment. As a result, we have seen a marked increase in the amount and quality of science teaching but, in many cases, at the expense of other segments of the curriculum not so richly endowed.

And now a new potentially great program under the Education Act. But, here again, outdoor laboratory centers, museums, and supplementary or enrichment centers will be successful only if they contribute to the total curriculum of the schools using them. In other words, only if they provide the most efficient experiences in search of meaning. It is your job as supervisors to assure that these centers do indeed serve the curriculum and do not become appendages which can just as well be chopped off.

On the basis of a few appeals for consultant help for Title III projects, I sense a need--a great need--for United States Office of Education consultant assistance and state consultant assistance to these projects. It is your job to get this.

Dr. Brandwein and I are at your service in the development of your new programs. Call us if you think we can be of assistance in the development of your total environments for education and your total education for total environment.

We will be calling on you in the development of our programs. In fact, I am calling on you now.

If you could make even a small contribution to America's space effort, you would start on it today. But in this even more important effort for man's survival, you can make not only a small contribution--you, as supervisors of your state's science education program, hold the keys to success. Will you start on it today?

## Highlights of the Discussion of Dr. Brennan's Speech

The following statements by Dr. Brennan were made in the course of discussion with the participants in the conference:

There is the statement that conservation teaching and conservation education, up to now, has been not just pretty bad but very bad. And this is the reason why we have started The Pinchot Institute. If it continues to remain bad, then our effort will have been wasted. But right now, we do not believe that the problems are insurmountable. We do not believe that this is not important, that it can't be done. We've only been working on this for a short time. Actually, as I mentioned earlier, we are not talking about a new curriculum, but the use of the present curriculum with new emphasis on places where it is deficient. I think you would all admit that we do spend a lot of time teaching a lot of things which are not important, as busy as we are. The reasons why conservation education has done so badly is because people have identified a lot of bad things with it.

The resource materials that are presently available for teaching conservation in the schools for resource use or whatever you want to call it, are not useable. I shocked the forest service a few years ago, after working there for almost a year. You must get a publication out once in awhile. This is sort of considered "the thing to do." After I worked for about a year and a half, I was asked if I had produced a publication yet for conservation education for the Forest Service, which is probably the largest producer of conservation education materials with the possible exception of the soil conservation service. I said, 'No, I haven't. Because I have about thirteen filing cabinets full of materials which have been produced by states and by agencies such as ours over the years and they're not used. And they're not useable. In each case, they were produced for something between the womb and the tomb with the hope that they would be used. Until we have a curriculum and courses of study which demand use of resource materials, they can neither be used or produced. We haven't produced any yet. When we do, you will be on the mailing list, I assure you.

So we agree. The education in conservation is pretty bad and the reason is because it has not been directed by educators and science educators in particular. That's why I wanted to talk to you today. I wanted to see to it that you will at least begin to think about your responsibilities in this area.

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I would say that anyone who cannot see the usefulness of an outdoor laboratory can't see the usefulness of an indoor laboratory either or, for that matter, any other laboratory. We just read to them, talk to them and never give them experience. If you don't believe that science can best be taught by experiences in search of answers, then no laboratory is involved in your method or your thinking. However, if you do believe that children learning to be scientists or learning to be scientifically literate can profit by experiences, then it's silly to say that they shouldn't go to a laboratory which provides the most efficient experience for learning that particular fact or whatever it is you're going out there for.

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There was another question raised as to whether sex education might not be more profitable. I think I did indicate that population is the most serious problem facing American, did I not? All the others are related to it. But this is basic. How do you teach population? How do you teach pesticides when there are no materials except the things put out by Shell Oil which say insecticides are great and Silent Spring says they're not. There are no materials produced by educators to introduce this important subject to the schools of America. This is the kind of thing I'm talking about. We could say the same thing about other areas. Population, pesticides: A teacher couldn't teach it even if she wanted to and was allowed to do so. There are no materials.

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Another consideration depends on whether you live in a city or in the plains; in all these cases, you have environment. You have to live in it. It has certain things that you need in it. You place certain restrictions on it. Everything you do changes it. I think that what you do and what everything else does in the way of change or in influencing this environment will be part of the knowledge or understanding of all the kids using that playground. That's all I'm saying. We ought to have an understanding of the world we live in. If it's an asphalt jungle, we ought to understand an asphalt jungle.

# ORIENTATION AND HISTORY OF NDEA TITLE III

George Katagiri
Science Consultant
Oregon State Department of Education

In 1958, when the National Defense Education Act was passed, there were only about a handful of science supervisors who were functioning with the departments of education in the United States and its territories. Since then, a new group of supervisors has evolved around the original nucleus. Today, there are anywhere between fifty and ninety state science supervisors or consultants whose regular responsibility is to up-rate the quality of science instruction in the different states and territories. Before the advent of NDEA, the situation in those states where science supervisors were lacking was generally primitive compared to the standards we now hold. Except for the high spots in isolated communities or an exceptional classroom, science instruction was predominantly reading or talking about programs.

The picture has changed and is continuing to change considerably. Many persons throughout the United States have contributed to this change. State Departments of Education have been and are an important part of this change too.

In less that eight years, we have, directly or indirectly, had much to say about spending millions and millions of dollars for the purchase of scientific equipment, materials, and laboratory facilities. In an increasing number of school districts, there is a developing educational plan which involves teacher committees. In-service sections have become almost as common as classroom instruction. Plan groups are becoming more concerned with excellence in teaching because of the competitive nature of college examinations. Business and industry are assisting educational projects to a greater degree than in the past. Many colleges and universities which have not specialized in science education are realizing the significance of the changing nature of the science curriculum. These are but a few of the major situations which are beginning to demand the services of the science supervisor.

For the most part, those of us who became supervisors for the first time are relatively inexperienced for the kind of work that we undertake. My guess is that most of us were probably good high school teachers. I think it would be the spirit of the expanding frontier that we have been able to make the progress that we have. If your feelings are anything like mine when I first came into this kind of work, it was more than once when you asked yourself, "What business do I have in this job." You went to meetings looking for specific answers which were appropriate for individual needs and problems. Those of us who have been to several conferences know that these answers do not exist. We have found that many aspects of science education are evolutionary. As a result, the nature of our responsibilities keep changing from year to year. In education, we are fortunate that in more and more areas we are beginning to depend on research findings to help us in making decisions and establishing policies. However, in the area of science supervision, research is limited: we need to meet periodically to interact and compare notes, documents and tentative guidelines for our actions.

I would hope that these guidelines, which are based on our experiences rather than on research, can be regarded as first approximations which will be subject to successive approximations as we develop greater insights. For the most part, this conference is planned as a working complex.

Through this conference, the rest of us do have an opportunity to pick up ideas with which we can become more effective in our respective positions under the Title III, NDEA program. This is the first chance that science supervisors have had to pick on each other's ways for more than one day. We will also have the opportunity to interact with some internationally known outstanding resource people. The extent to which each one of us can draw professional confidence will depnd on how effectively we can interact and exchange ideas in the next four days. We are certainly grateful to the United States Office of Education for making this meeting possible.

# THE PRESENT AND FUTURE STATUS OF NDEA TITLE III

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U. S. Office of Education

It was a little bit difficult, when I was given this assignment, to determine just where to start to get the national picture because most of you have heard the national picture many times. I decided that the point and time where I would start would be about two years ago at the time when the five subject matter areas were added to the other three that have been supported under NDEA, Title III.

For my assignment today, I would like to discuss three questions with you: First, what effect has the addition of five subject matter fields had upon the expenditures for equipment in science? The second question is, why was the second request for fiscal year 1967 reduced by about $25,000,000 when compared with the appropriation for NDEA, Title III for fiscal year 1966? Third, I would like to discuss very briefly what I see in the future for NDEA, Title III.

Now, for the first question, what has been the effect of the addition of five subject matter fields for NDEA, Title III? You know roughly 75 per cent of the total expenditures that were made under NDEA, Title III. Another way of putting this would be to say that $3 was spent for science to every $1 that was spent in mathematics, art, and foreign languages, Now, if we look at the expenditures for 1966 or 1965, we would find that now $2 is spent for the acquisition of science equipment and materials and remodeling to every $1 that is spent for the other seven subject areas. So we see a reduction in expenditures from about 75 per cent of the total expenditures now to about 66 per cent.

As we look at dollar amount expenditures over the last three years, we would find that the expenditures for science reached a peak in fiscal year 1964. In 1963, approximately $39,000,000 of federal funds was spent on science under NDEA, Title III. In 1964 this jumped to $49,000,000 and then in 1965 it dropped back to $42,000,000. I think this reduction of about $7,000,000 undoubtedly reflects the addition of the five subject matter fields plus the fact that many local districts believed that, under the policies of the Elementary and Secondary Education Act they would be able to use Public Law 89-10 funds for purchase of equipment and materials without providing matching funds at the state or local level. This really hasn't been the case with regard to the effect of the various titles under the Elementary and Secondary Education Act on NDEA, Title III expenditures insofar as I can see. All that we have for reports this year are basically informal and involve requests of reallotment for NDEA, Title III. The information I receive would indicate that more money is being spent this year on NDEA, Title III than ever before and the request for allotment would bear this out. I was talking with Marjorie Johnston just a moment ago, and we find that there is a request this year for a $16,000,000 reallotment which is being announced today. I believe only about a $2,000,000 reallotment is available.

As we look at the supervisory and related services forms and those which are used for the administration of NDEA, Title III, we note that there has been a gradual increase in the amount of money that has been extended each year. The increase from 1964-65 was the largest that has been experienced so far. About $750,000 was added at that time bringing the expenditure to an all-time high, as far as federal funds are concerned, to about $4,000,000 toward the support of state level activities under the eight subject matter areas. This increase appears to have gone into the other five subject matter areas. At this time, it appeared that the number of state supervisors was leveling off somewhere between 90 and 100 for the nation. It is interesting to note that $3 is spent by each state department of education for supervisory services for every $1 that is spent for administration in NDEA, Title III.

The next question which is on the minds of all of you is why was the 1967 budget request cut $25,000,000 below the 1966 appropriation? To be quite honest with you, I think I would have to say that I don't know. I think we should discuss it, however, and perhaps we will develop an insight into just what has happened. Some discussion of the mechanics for generating budget requests and a run-down of the departments who have judgment upon them might give you some insight as to how changes could have come about. The budget request, appropriations, estimates, whatever you wish to call them, are initiated at the base level. Marjorie Johnston is responsible for this; once she intiates it, it goes to the division; from the division to the bureau; from the bureau to the commissioner's office then back to the bureau of the budget; and, finally, to the White House. Every one of these levels can modify the budget, either up or down, depending upon whether or not they think this program is important and how much they know about it. What eventually comes out of the White House and is requested by Congress is what the members of the Office of Education must support.

Realistically, I think the reason that the NDEA, Title III appropriation was cut was due to the Viet Nam situation and the resultant increased expenditures for the Department of Defense. Perhaps there may have been people in the Office of Education who reasoned that federal money in Titles I, II and III of ESEA could be used to buy equipment and materials which before would have been purchased under Title III of the National Defense Education Act (both local and federal funds). As I have said before, this does not appear to be a reality.

From what I hear in the field, it would appear that the effect of the Elementary and Secondary Education Act upon expenditures under NDEA, Title III has been accelerated as a result of the policies of the Elementary and Secondary Education Act. What are the reasons for this? One of them is that Title I and Title III of the Elementary and Secondary Education Act place low priority upon the expenditure of funds simply for acquisition of equipment and materials which channels money into other areas.

What are the prospects of NDEA, Title III for the future? As I listen to people talk in the Office of Education, I hear much discussion as to how the Office of Education can put together the pieces of categorical legislation so that they will combine to form programs which are more meaningful for the support of elementary and secondary education. The way these pieces are being fitted together indicates that part of the Elementary and Secondary Education Act monies will be used for the research and development of ideas and programs in elementary and secondary education.

Title III of the Elementary and Secondary Education Act will be used to disseminate and diffuse information which has recently developed. The primary way in which this will be done is through the establishment of a few small scale demonstration type projects scattered throughout the states. Some of these practices will be successful; some will be failures. NDEA, Title III, ESEA, Title II and ESEA, Title I will be the source of funds for large scale adoptions of the successful programs that have been initiated through the type of strategy I have just indicated. As these discussions take place, money is also associated with it; as I hear NDEA, Title III discussed, I hear larger sums of money projected in the future for this Title than the present authorization of $88,000,000 for the acquisition of equipment and materials.

What is the future of NDEA, Title III? When the Viet Nam situation is resolved, as our population increases and our technology continues to accelerate; no alternative exists except that of increasing NDEA, Title III appropriations.

## Highlights of the Discussion of Dr. Wickline's Speech

In the discussion period which followed his speech, Dr. Wickline was joined by Dr. Marjorie Johnston, Director of Instructional Resources Branch of the United States Office of Education. Questions pertaining to subject specialists and procedures for obtaining professional help from the United States Office of Education were prevalent. In regard to this, Dr. Johnston stated: "The question of how can you obtain adequate professional help in education is very dear to our hearts too." We have lost some of our key people to the ESEA program, and we very much hope to try to get more professional services to continue the program reviews that were suspended while we were launching the new program. That doesn't mean that we'll have a science specialist for all the program reviews. We'll use our small staff and spread ourselves very thinly. However, we try to do as good a job of teamwork on the NDEA, Title III program as is possible. I think Lee will probably bear me out in this in that it has always been our custom in staff meetings to learn from one another. In this way, the science person learns a great deal about the instructional goals and problems in modern foreign languages and mathematics and vice-versa. Since the expansion which included five new subjects occurred, I am still very short-handed; we are all working together as much as possible. Even if we can't send a science specialist on our review, the person who does come from our office will be happy to bring back questions that he might be unable to answer as well as relay requests for specific help in this field. We'll do our very best to honor these; it would be precisely the proper time for us to hear from you as concerns your needs and your desires from our division in the field of science.

With regard to the reduction of money available under NDEA, Title III, Dr. Wickline commented, "It was my conclusion several years ago that, if we continued supporting the equipping of science laboratories at the rate at which we had been, it would take 35 years to put good laboratories in all of the high schools in the nation. I would agree with you that there is much need for funds to support science in our elementary and secondary schools for a number of years. In my projections, I ignored the pleas for the elementary level completely; the estimate cited would be valid only if we used all of the funds for the secondary level. That is what it would take."

The Office of Education, as you know, was reorganized a year ago, and has undergone several minor reorganizations since then. I believe that, after the reorganization has taken place, and we have had time to face some of the problems that inevitably will arise, the role of the specialist in the Office of Education will be received more favorably. One just cannot administer programs that deal with special subject matter areas without having someone in the office who knows something about administering them. Dr. Johnston now is in charge of a branch which uses such specialists. Unfortunately, the number of positions which she has at this time, is limited to ten.

"As far as NDEA, Title III and Title V are concerned, they were ignored for a period of a year or a year and a half in an attempt to get other legislation in operation. These programs will suffer if we continue to ignore them. I really don't know how this can be approached. Suggestions are made in the office; within the last two months justification has been established which emphasizes the importance of the specialist in the office. Any types of reactions which you would have, especially your opinions to the Office of Education, would be helpful. These should be sent as a formal communication."

In answer to a question, Dr. Marjorie Johnston pointed out that an item by item review of mateials in project applications is no longer necessary; however, it is still necessary for equipment. The burden for justification for items of materials rests on local school districts.

There was considerable discussion of the acquisition of books under Title III, NDEA. Dr. Johnston pointed out that Title III, NDEA was not basically a program for improvement of libraries but, rather, a program to improve instruction. Books for reference purposes might be justified as a means for improving instruction. Dr. Johnston also pointed out that efforts are being made to simplify NDEA reports to the United States Office of Education. She emphasized the importance of narrative reports. Even though subjective, they are of much value in justifying the need for continuance of NDEA.

Finally, the need for science supervisory personnel on a regional or district basis within states was pointed out. Since different state supervisors had to contend with administrative districts ranging in number from 16 to 1400, it appeared obvious that district supervisors were essential in implementing curriculum revision programs, in-service training programs and other responsibilities.

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# ESEA TITLE I AND COMPENSATORY SCIENCE EDUCATION

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Title I of the Elementary and Secondary Education Act of 1965 was enacted to provide funds to local school districts for providing better educational opportunities to deprived children. In order for a district to receive funds, the district had to make an assessment of the educational needs of deprived children and arrange those needs in some order of priority by listing the most pressing needs first. By definition and encouragement from both state and federal sources, the lack of children's ability to read was generally listed as the most pressing need.

As Director of Program Development, I am not here to talk to you about developing a reading program. But, I believe, you will agree with me that it is futile to try to teach a child who cannot read. The reading people (at last count) have some twenty to thirty different reading programs at their disposal of which most are excellent. Why, then, can't children read after they have received instruction? It appears a child must have three things going for him in order to learn to read:

1. He must be physically developed in the neural tissues to be able to perform the act of reading.

2. He must have developed a language that is compatible with the sentence patterns and vocabulary of the material he is to read. The language will develop from the experiences he has had and to which he has attached symbols for relating to or describing those experiences.

3. He must be motivated to read by having material of interest available to him.

The educationally deprived child generally has not developed a language adequate to succeed in school through either the lack of opportunity to symbolize about his experiences, the lack of the necessary experiences, or the incompatibility of the language he has developed with the requirements of the school.

Now, where do you fit into this picture? Frank Riesman defines the deprived child as a physical learner who is slow in performing many tasks. Reisman thinks that these two traits, slowness and physical learning, should be put to use in teaching the deprived child. Generally, the school curriculum is developed around verbal attributes that reward speed. This handicaps the deprived child.

Another fallacy in our standard curriculum is assuming that all children have had similar experiences before coming to school. I dare say that many of you would perish in the same environment in which many deprived children under ten years of age flourish. Their experiences are different from those of middle class children.

Now, with these three points in mind, physical learning, slowness, and a different background of experiences, I challenge you to develop a science curriculum beginning at the pre-school level and continuing through the secondary school that will fit the needs of these children. The curriculum I am talking about will require the development of sequential concepts in science beginning in the pre-school years--say age three, devising tests to determine the basic concepts the child has developed through experience so that you may begin instruction in keeping with the child's development; and devising an instructional program that will include the sequential experiences to develop the concepts needed for contined intellectual growth.

Now, do not look for ways to make the child average or have, as one of your objectives, his placement into the mainstream of education of the traditional curriculum. According to the Report of the National Advisory Council on the Education of Disadvantaged Children, recognition must be given to the fact that as long as a child is subjected to handicapping influences outside the school, the curriculum must take account of those influences and respond constructively to them. It is essential, therefore, that the need for reconstructing their curriculum be viewed as extending from the pre-school years through the high school. Specific innovations aimed at particular problems must be complemented by other approaches that are broadly comprehensive. The Council urges school systems to shed outmoded approaches that are ineffective and seek new curriculums that will allow the student to explore verbally, intellectually, and with his hands, in a secure and pressure-free (plenty of time to complete a task) environment. We must give him the chance to explore, we must let him do this at his own pace. More could be said, time will not permit a further exploration into the characteristics of the deprived child.

I do not believe that I could do this alone--neither do I believe I could assist in getting the job done with only fellow science educators. I do believe the curriculum can be developed if we accepted the philosophy of the pony engine and add reading specialists, psychologists, sociologists, linguists, and other curriculum area people to our train and say, "Let us pull together." The curriculum should provide a total learning situation so the deprived child will develop a language, learn to read, and become a useful productive citizen.

Remember, to paraphrase Newton's laws

1. The non-learner tends to remain a non-learner and the learner tends to remain a learner unless acted upon by an external force.

2. The attitude of the teacher about the ability of the child is reflected in the performance of the child! The result is direction proportional to the attraction between the two.

3. For teaching to be accomplished, learning must take place.

## Highlights of the Discussion of Mr. Phillips' Speech

Following his speech, Mr. Phillips was asked if science couldn't be learned by youngsters with low reading ability; and if the multi-sensory, activity-centered approach to science teaching might serve as a motivating force to improve reading interest and competence.

In replying, Mr. Phillips stated, "I did stress reading, but, if you will note, I also said that the deprived child is a physical learner. Therefore, science provides the experience on which the child may use in learning and in developing a language; after he has had the experiences and developed the language he can read.

In reference to a question about what the state science supervisor could do to further Title I programs, Mr. Phillips replied, "I think the answer here is one word--leadership. If you will provide leadership, if you will provide programs for school administrators and teachers to use in the Title I program, they'll use them. They are looking for your leadership. I think we have probably had our heads looking up at Sputnik so long that we have failed to look around us and really provide the leadership we need. Strictly in Title I, the deprived child, by and large, is not in the high school program; he is not in the secondary program. He has been sifted out: we must find ways to get the deprived child into the secondary program. The impact of reading of Title I has a very simple explanation. How do we identify deprived children? The educationally deprived? We use verbal tests; if he can't read the test, he makes a low score. If we find some other method of making identification of the concepts he actually knows that can be expressed, non-verbally, we might be able to direct our attention in some other direction.

"I must rise to the defense of the three-year old. In Benjamin Bloom's book called Stability and Change of Human Growth and Development, he makes this statement. I'm not going to agree with it or disagree with it; I'm going to pass along to you his find in research. "Fifty per cent of the general educational achievement of the language development that a child will exhibit at age eighteen has been established by the age of nine. Thirty-five per cent has been established by the age of six." This is a pretty serious indictment of our public schools if we do not move back down. Now I'm not saying this is the thing that must hapen. It is what has happened, and is simply research reported by Dr. Bloom."

# ESEA TITLE II AND SCIENCE SUPERVISORS

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In order to talk about the effect of Title II of the Elementary and Secondary Education Act on science supervision at the state level, I think it is necessary to go back and summarize for you just a little bit of what Title II is all about. Much of this may be familiar information to you. Title II is a state plan program whch provides a hundred million dollars to the states for the acquisition of school libarary resources, textbooks, and other instructional materials. These three categories, school library resources, textbooks, and other instructional materials, need to be understood before I can go any further in talking about the Title II program. These are rather artificial categories, but I think you will understand the distinctions and the reason that these distinctions are necessary. School library resources are books, periodicals, pamphlets, documents, photographs, reproductions, pictorial graphic work, musical scores, maps, charts, sound recordings including discs and tapes, processed slides, transparencies, films, filmstrips, and video tapes. You may well say, "What else is left?" The law goes on to say that any of the other types of printed, published or audio-visual materials are to be developed.

One omission which you may already be thinking of is microfilm; microfilm materials are eligible under Title II of this category. The second category is textbooks. The definition of textbook is "a book, reuseable workbook, a manual, whether bound or in loose-leaf form, intended for use as a principal source of study material for a class or a group within a class." The third category, other instructional materials, includes all of those same types of materials that are named as the library resources.

The difference between the first and third categories is that the other instructional materials would not be organized for use in a school library or in an instructional materials center. These categories have been somewhat difficult for people to understand, and we've found them useful, particularly in one respect. In defining these three types of materials, it is necessary for us to explain that school libraries are not places where you have only books or other printed materials; it is an instructional materials center, resource center, or any equivalent term which you might use and which includes materials of all the types which I have just named.

In the state plan, the states expressed criteria for proportion among these categories; you may be interested in knowing the trend for purchase of these three categories of materials within the states. I'm sure you know the allotment for your own state. The majority of the states, on the basis of their statistical needs, have given priority for at least the first year of Title II to school library resources. For example, ten of the states will spend 100 per cent of their money for school library materials, twenty of the states will spend 75 per cent of their allotment on school library resources, fifteen will spend 50 per cent of their allotment on school library resources, and 43 of the states will spend no more than 25 per cent of their allotments on other instructional materials. You see, the third category, other instructional materials, is actually intended for those schools that do not have organized libraries. This would be primarily elementary schools or very small schools in rural or isolated areas. The category which has, at least for the first year, included the least amount of the funds under Title II has been for textbooks.

There are 28 of the states that, because of adequate local and state provisions for textbooks, will spend no money during the first year for textbooks. Only Puerto Rico will spend more than 25 per cent of its money for textbooks. Most of the states have fallen within five per cent to fifteen per cent for textbooks. One other piece of background information before we go into the implications for science supervision at the state level: The funds that are made available to the state under Title II ought to be made availabe to children and teachers in private and public elementary and secondary schools on the basis of the relative needs of children and teachers in various school districts and in various schools for these materials. Thus, it is required that the states make an assessment of materials that are actually available in the school to children and teachers.

These patterns of relative need have been almost as varied as the states themselves. Many of the states have used standards. For instance, one of the standards for school libraries is the amount of books available per child. If the high standard is 10,000 volumes or six books per child, the state may have established categories of schools. Schools that have, let us say, two books per child would receive more materials under Title II than a school where there are six books per child and so on. Other states in working out their relative need criteria used a series of priorities of needs. All of the figures that we have on instructional materials and school libraries indicate, for instance, that the type of school and the category of children which seem to be in most need are at the elementary level. Because of this, elementary school libraries have received a real boost under Title II. Children and teachers in various schools with a large number of gifted children and schools with advanced placement programs or very small secondary schools with inadequate instructional materials have been high priority. These patterns of relative need are most interesting and have, I think, great implications for improving instruction in the state. This has been a very brief summary of the background of Title II: I'd like to say just a few words about some of the trends in Title II that seem to have special implications for you as science supervisors at the state level.

Materials allocation, for the first year, has emphasized school library resources for use by children and teachers in elementary and secondary schools. This emphasis will probably continue in the year to come. You know that children and teachers in elementary schools are in most need of library resources. Elementary schools will have libraries established where none have previously been organized, and those that have previously been organized will be strengthened. The teachers and the librarians in these schools where great effort is being made to establish and improve elementary school libraries will have great need of assistance in selecting and using materials. This, I think, has special implications for subject specialists and for your group.

A second important outcome in Title II is that all types of school libraries are going to include development of selections of non-group materials. Because of all of the types of non-group materials that are eligible under Title II, the schools' faculties are going to have real need for assistance in selecting and using good films, filmstrips, recordings, charts, and all types of printed and published teaching materials. Successful use of these materials, and you know this as well as I do, does not come by doing what comes naturally. You must learn how to use materials. A teacher who has only a very vague idea of how to use filmstrips in science education is really not much better off than if he had no science filmstrips to use.

One of our problems, of course, in using audio-visual and non-group materials, is that the selection, organization, and preview of these materials is more difficult than is the case with printed matter. It is relatively easy to look at a book or to look at a few issues of a periodical and know whether you want to use it or not. To have a projector, a screen, a place to look at film and the time to do this presents a problem. Another is bibliographic control of these items. As inadequate as our booklists are, we do have good science booklists for children from the National Science Foundation. But where do you start when you're looking for a good list of films, filmstrips, and program materials that have been more or less pre-selected for you? We're all familiar with the stacks of catalogs, guides, ideas, and other lists which come across our desks; but many of these, as you know, are incomplete, inaccessible, or inadequate in meeting our needs for the selection of materials. Science supervisors, science teachers, science specialists, and specialists in all instructional areas who have competency in the selection of materials in their field can assist state and local Title II personnel in separating the wheat from the chaff in this flood of printed and published material that is rapidly overcoming us.

Another one of the problems that we have with our non-group materials, or audio-visual materials in Title II, is that the emphasis on the operation of machines in the concept of instruction material centers has created a kind of hardware image in the minds of some teachers and, I'm afraid, of school librarians. Subject specialists, of course, must encourage greater use of audio-visual materials so that we can overcome this hardware image and get to the real problem of the situation which lies in materials and instructional materials and the use of the materials in the instructional program. The Title II program provided five per cent of the state allotment to administer their program the first year. This has meant, and I'm sure you are aware of this to some extent, that state education agency staffs have been strengthened by the addition of school library specialists and other specialists with competence in selecting and using instructional materials. Services in instructional materials from these people who were brought in under the Title II program are, of course, very important. But services from all the area specialists are essential to the success of the Title II program.

The real heart of the Title II program is not the artificial separation of instructional materials from the school library. The concept of a school library is to provide instructional materials in the school library, in the classroom, in laboratories, and all study areas throughout the school as well as materials for the use of our children and teachers outside the school. Only when school library resources, textbooks, and other instructional materials are made acceptable to children and teachers and related to the improvement of the instructional program can we really achieve the objectives of the Elementary and Secondary Education Act. Those objectives are, as you know, to strengthen instruction and improve educational opportunities for children throughout the nation's schools.

## Highlights of the Discussion of Dr. Jones' Speech

In the discussion period following Dr. Jones' speech, concern about the flood of new library materials and spiraling prices of materials was voiced. Questions were raised about problems in the selection of materials, both for the average learner and for the learner with special reading problems.

Dr. Jones responded by saying, "Many of you apparently expressed concern in your groups over the selection of material, and, of course, this is perhaps our chief problem. We have been flooded with printed and published materials prior to Title II and to other federal programs, and with the passage of these bills we have experienced another terrific flood of material. We have a most serious problem in trying to extract from this flood of materials what we can use and need to use in our various instructional programs. We have prepared a list of lists in the Office of Education in our Division of Book Selection for children and teachers in elementary and secondary schools. I will be glad to send copies to you if you will write to me. This is a list which includes only printed materials. We are hoping to prepare a similar list which will bring together some of the lists of audio-visual and non-printed materials.

At least one of your groups expressed concern over the location of materials for children who read below grade level or have problems in reading. The list of lists mentioned above suggests both science and general materials which might help these children. This list also includes some lists which are other than those published by the AAAS which you may use in selecting materials. All these lists have their limitations. When you, as science supervisors, look at them you should be quite aware of what the limitations are. We certainly do not want to put ourselves in the position of limiting any school in the selection of materials to those materials included on the list, but these would give you a starting place in working with teachers and supervisors.

Another one of the questions concerned the price of materials, and I assure you that we are quite concerned about this. We have been making some studies of price increases, but have not completed them. We have objective as well as subjective evidence that prices have increased. One of the places that I think you can particularly watch for, is in the way materials are packaged. You have probably noticed in the catalogues and other materials that cross your desk that there seems to be a trend to put a great many materials in a box and sell it for a price above that which you might pay for the individual items. This is something that you might want to think about and caution teachers to watch.

Many of the participants of the conference were concerned about the possible overlap of coordination between NDEA, Title III and ESEA, Title II. Dr. Jones commented, "I think most of you are aware that there are some subject areas which can be included in ESEA Title II that are not included in NDEA Title III. Also, NDEA, Title III has been used chiefly for secondary schools and ESEA Title II, for the most part is directed toward the improvement of elementary library materials and other instructional materials. We do hope to raise the number of materials available.

One discussion group raised questions about the merits of centralized and decentralized (or classroom libraries). With regard to these questions Dr. Jones said, "I realized that, to some people, the centralization of school libraries has meant actual deprival of children and teachers of materials rather than acceptability. We encourage centralization of materials only as a means of organizing and processing materials. After this, we would expect that the school library would be a place where materials could be used as well as one from which materials would be sent to classrooms, laboratories, and all study areas throughout schools for long-term, short-term loans, and indefinite loans, or in whatever way the materials would best be used.

Some schools, and this happens particularly at the secondary level, are beginning to organize departmental libraries as a way of making materials more accessible to children and teachers. One particularly good instance of this is the Oak Park River Forest High School in Illinois. They have been the recipients of a Title III, ESEA project and the Knapp School Library project. They have established departmental resource centers, and employed a librarian in three of these centers who is a subject specialist. They have a librarian in science-mathematics; social studies, and fine arts. The librarian with science-mathematics background is very hard to come by. Most librarians, as I am sure you are aware, have a background in the humanities or social studies. We have a tremendous need of assistants in selecting materials that fall outside these two fields.

Dr. Jones was asked about the matter of teacher participation in the preparation of project applications under Title II. She replied, "We certainly do encourage this. In fact, a project application that has not been prepared by a representative of the various departments of the school is really one that we would hope would not be accepted. We would like to see participation of all teachers in preparing these project applications. I think one of our problems with this year has been the haste with which we have had to implement Title II. Some of the state plans were submitted late and involved a great deal of haste in encumbering available funds before the end of the fiscal year. Perhaps these problems will be alleviated to some extent in other years. In the state plans, the criteria for selection of materials have been established from state to state, many states have recommended, through their guidelines, other lists of materials which you might be interested in checking out. The coordination of Title II with other settled programs is another item I think most important for consideration. In the case of Title II, ESEA, for example, librarians have been employed in schools as district supervisors for library programs. Title III, NDEA can be used for not only remodeling of all of your visual libraries, but in the implementation of these programs for the ultimate improvement of instruction.

A final comment I would like to make is that if ESEA, Title II, and NDEA, Title III combine, we would still not be able to close the gap that exists in instructional materials in schools. With our present expenditures, and the addition of between eight and nine million dollars, it would take about twelve and one-half years to close the gap in school libraries for books alone. This does not include any other type of materials. Another one of our problems, of course, is where are we going to find school librarians to assist teachers with the organization and utilization of instructional materials? We are scrambling for these same tools of labor. The estimate is that we need about one hundred thousand librarians in our schools. We have some assistance with this through NDEA, Title II programs; but this as yet is the problem that I think has been unanswered.

# ESEA TITLE III AND INNOVATION SCIENCE PROGRAMS

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U. S. Office of Education

Title III of the Elementary and Secondary Education Act supported by a Congressional appropriation of 75 million dollars was passed to improve elementary and secondary education. The purpose of the Act was to provide funds to bring about educational change; the way that this is being attempted is to put the money into what is called innovative and exemplary projects. As soon as we use these words, some people begin asking just what do we mean by an innovative project? What do we mean by an exemplary project? I think perhaps the best way that we could describe an innovative project would be to say that it is simply an educational invention which means that we have taken old knowledge, we have taken old practices, we have taken the findings of research, and recombined and restructured them into new combinations which give promise of being successful and of improving education.

To give you a couple of examples of what I would call innovative projects, I would refer to Joe Struthers who is a member of this group. I would like to read to you how the project he helped to develop is described in the Pacesetters booklet here: "An exemplary science program will be developed involving teachers, as co-researchers, to increase their understanding of instructional strategies for developing creative and critical thinking." I would also call your attention to the fact that Dr. Butts yesterday mentioned that they were using ESEA Title III funds to disseminate information concerning the AAAS project across the state through a series of what they called supplemental centers. Now, to me, both of these programs are in the area of innovative types of science activity.

Now what is an exemplary activity? We described this as being an activity of the highest quality which can be demonstrated with large groups of people to show that it is successful. We would hope, then, both for the innovative program and the exemplary program; once administrators and other professional personnel see that this program really does work they will use either state or local funds or funds from the other titles under this Act and under NDEA, Title III, to adopt these programs and provide a widespread introduction of them into the schools. ESEA, Title III, is not envisioned as a program which would provide services and activities to all students in a school system or in a state. In fact, it is not even interpreted to mean that you would introduce a series of the same type of program in a state. Rather than having, say ten science centers which can build around ten planetariums, we would hope that you would have ten different ideas in a state. We prefer to fund ten different ideas than to fund one idea ten times. I think this is important for people to know as they write science projects.

Next, we should look at the number of project applications that we have received. We have had two deadlines, and have received 1,717 project applications in the office. The last count taken revealed we had funded 642 of these during the first two deadlines. There are perhaps still fifty projects in the whole category that we are negotiating. Out of 642 projects that have been funded, about sixty of them are in the area of science education. I would say of that sixty, approximately 45 of them are truly science education projects and about fifteen of them are involved in large umbrella types of projects which include science as one of several facets.

As we look at the various kinds of projects that have been funded, we note that many of them are in outdoor education; we have them in conservation, marine biology, oceanography; some are oriented around planetariums. They emphasize activities we ordinarily do not find in the school curriculum. The last deadline period, which was May 25, we received 1,000 project applications. We expect to make announcements on the number that have been approved during the last two weeks of July.

If we look at the projects and analyze them, I'm sure that you would want to know why two out of every three were turned down? The basic reason was that the project applications that were submitted did not really involve innovative or exemplary ideas. There is no question that a local district needs more equipment and more materials. They need to do more in-service work, but what they were attempting to do with ESEA, Title III funds was the kind of thing that has already been done many times and is already being done somewhere in the state. This, then, is the main reason.

One of several policies which have been established by the advisory committee for this title concerns the non-funding of new construction. Any project, therefore, that is submitted and involves new construction will not be funded. Secondly, projects which involve heavy requests for acquisition of equipment and materials are not being funded. We don't envision ESEA, Title III as being an equipment and materials project. To give you a rule of thumb that is used in the Office of Education, any project requesting more than fifty per cent of the total budget for the use of equipment and materials is automatically turned down.

As far as the evaluation of projects is concerned, it is obvious that the proposal which comes in with a request for the acquisition of equipment and materials that is only 25 per cent of its budget will receive higher ratings and evaluations than one that would come in with fifty per cent. This gives you some idea of how projects are evaluated.

One other weakness of project applications is the lack of awareness on the part of research participants in a particular field in which the project is being submitted, or the lack of awareness that a similar project is going on in the other part of the country. It is a type of local provincialism I suppose, which implies starting from scratch again rather than finding out what other people have done and trying to build upon what already has been accomplished. Another of the greatest weaknesses of project applications is that they involve very poor procedures for evaluation.

Lack of specificity is common on all of the projects that are disapproved. People will say what they are going to do, but they won't say how they are going to do it. You can read the project application and it sounds good, but you don't know the programs or the procedures to be used; the steps to be taken; whether or not they will involve consultants who are really knowledgeable in the filed or whether they will employ someone who doesn't have much potential to contribute to this type of program.

Perhaps I should describe the methods that were used in evaluating project applications. As you know, the Title was administered directly by the United States Office of Education. When an applicant submits a project application, copies are sent through the State Department of Education. The State Department of Education makes reviews and recommendations which are sent to the United States Office of Education. At the United States Office of Education, three sets of reviews are made. These are carried out, in part, by a group of outside readers of about 120 consultants who are people of national stature scattered across the nation. They submit their recommendations as to whether or not a project should be approved, disapproved, or should not go in either of those categories but placed in a hold category so that the Office may negotiate with the applicant to try to strengthen certain facets of the proposal.

Reviews are then held within the Office of Education. The Instructional Resources Branch reviews all project applications which then go to the Bureau of Research for further review. Thus, there are three reviews, in addition to an area review which consolidates the reviews of the outside readers, the Instructional Resources Branch, and Bureau of Research.

Only one reading is now made within the Office of Education. This is either in the Instructional Resources Branch, the Bureau of Research, or other areas where we have specialists. This is very easy with a project in a single subject area, but becomes more difficult when you have an umbrella type of proposal which involves science, social studies, educational television, and others.

In examining the role of the Council of State Science Supervisors, or that of the individual state supervisor, enormous possibilities under ESEA, Title III appear. It would be possible for you as a group to determine, for example, the ten most innovative ideas in science education--the ones you really would like to see demonstrated across the nation. Each supervisor could, through a cooperative effort, pick up one of these kinds of projects for demonstration. Perhaps you don't want to do this on a national level; it could be done on a state level. Again, within your state--you could select the kinds of ideas and exemplary programs that are not presently in your state and work with your local education agencies to see that these project applications are submitted. This is one way that you could move toward the identification of demonstrated ideas.

Another approach you might take would be to identify significant research in science education. Most of us (and especially the people at the local level) do not have the time necessary to sift out the data to identify the really significant research studies. I was particularly interested in the discussions that Dr. Addison Lee gave earlier concerning the Educational Research and Information Center at Ohio State University, which would devote all of its efforts to the dissemination of research information in science education. I hope you follow this development very carefully. This Center could be a place where you could obtain information to give to interested science people within your state.

Another role that the state supervisor can play is to organize training conferences within your state for the writing of project applications under Title III. I know all of us are concerned about the fact that the sophisticated districts usually have the money and personnel, can employ consultants, and write good project applications. I think that there is an implication here that one of the responsibilities of the state science supervisor is to help the less sophisticated school district. Perhaps this can be done best by working with groups of people in helping the less sophisticated school districts to develop good project applications. There are other ways in which you can help in working with ESEA, Title III. You can ask to evaluate Title III proposals that are submitted from your state in the field of science by volunteering your services to the Title III state coordinators. If you don't have the time to do that, suggest people in science education who would be competent to carry out such reviews. Many states have advisory committees who do this type of activity.

I would like to call your attention to three publications. I would judge that all of you are familiar with them; if you are not you can obtain them either from your ESEA, Title III coordinator in the state, or you may write directly to me. We would be happy to send you all the copies that you would need. First among these are the Title III guidelines which include an interpretation of the Act, the regulations, and the priorities established by the advisory committee. It also includes a format to be followed in submitting a project application. There are two other publications all of you should have. These are two volumes of the Pacesetters. These give a synopsis of the 642 projects that have been approved as of this date. I would caution you that just because a project has been approved in one state does not necessarily imply that it will be approved in another. To give an example, a project that would be exemplary in a rural district would be "old hat," say, on Long Island, New York. It would be approved in one place, but not in another. As such, there is some danger in attempting to copy project applications that have been approved. On the other hand, the Pacesetters provide a number of ideas that can be combined and developed into excellent projects.

The next deadlines under ESEA, Title III will be September 1, 1966. These will be for project applications which will get underway the second semester of the year. The next deadline will be in January 1967 for project applications which get underway in September of the following year. After this deadline schedule on which we are operating now, we will only have two deadlines a year.

## Highlights of the Discussion of Dr. Wickline's Speech

Dr. Wickline was asked about the identification of needs in science education. The concern was that, instead of putting money where it really counts, it might simply to to fund someone's pet idea. Dr. Wickline's reply was, "I think this is a real problem, or could become a real problem, and I think there are two ways that it could be solved. One is to have people who take the overall view of the crowd picture. Ideally, this would be the state science supervisor or it could be a local science supervisor as these people develop. Another approach is to use ESEA, Title III planning grant projects to assess the needs of an area and then to establish priorities of these; and then of course to start writing project applications in the areas where we have the greatest need and the greatest priority. There is some danger, and we are in a type of dichotomy here of just the local school districts making selections of the types of projects they want funded. The result could be a type of grab bag thing, especially when we have planetarium salesmen coming in and convincing the local districts that their greatest need is a planetarium. Or we have film salesmen coming in convincing them of the same thing. We do need someone who can get back to the local situation and assess all of the needs and give some type of professional value judgment on what is important.

As for the coordination of the new programs pertaining to science, I really don't know what the solution is. We do need more state science supervisors for, as our jobs become more complex, there are more facets to it. As funds become available under Title II and Title III of the Elementary and Secondary Education Act, it seems imperative that we do have professional science people involved. Your responsibilities are much greater than they have ever been before; but it still seems to me that we do have a role to play in ESEA, Title I, II, and III, in the surplus property program and any other program where there is need for science leadership. This also applies to the submission of project applications under ESEA, Title III in that we attempt to use all of the resources that are available. If we cannot use ESEA, Title III for the acquisition of all the equipment and materials that we need, certainly there are other resources such as NDEA, Title III, and ESEA, Titles I and II, where funds are available for this specific purpose."

A question was raised concerning the submission of multi-field types of project applications. The problem discussed was how to best submit these applications so that science sections with special merit would not get lost. Dr. Wickline answered, "The easiest approach for us to handle in the Office of Education when we have a multi-field unbrella type of proposal is for it to be made up of discrete parts. In other words, there would be a science project and a science budget broken out with ten other budgets which are summarized in the overall proposal. The reason for this is that we can get science specialists to read this particular part of the proposal, or if we would find that there are other parts wich are not acceptable, we can take them out easily, subtract them from the total budget, and then fund a portion of the total proposal rather than letting the whole thing go down the drain."

Some participants questioned the justification for the policy which limits projects to no new construction, and fifty per cent acquisition. Dr. Wickline commented, "I think really that this has served to the benefit of all programs. I'm sure as is occasion with any policy that there are certain circumstances where perhaps an exception should be made. Sometimes we feel that we cannot make exceptions. First, only seventy-five million dollars was appropriated for this program the first year. I would remind you that there are 26,000 schools districts in the nation and that all 26,000 schools districts would like to have buildings, structures. You know as well as I do that it doesn't take much of a building to eat up half a million dollars or a million dollars; and I'm afraid that if we put our money into construction that all that we would have would be types of monuments which would be similar, sometimes, to the kinds of equipment and materials that were purchased under NDEA, Title III early in the game. We have the beautiful equipment and materials in the laboratory but we didn't have the type of leadership that we needed, the in-service programs that we needed so that the teachers would be able to use them. So, generally, I think it is a wise policy. In certain circumstances, I'm sure, it imposes handicaps on certain schools and in certain areas. I do think that there is a good possibility that this will be relaxed when the money is not being poured into the Viet Nam situation, and when budgets are escalated. In education I'm sure that this will become more flexible. President Johnson, in his budget request to Congress, has specifically requested that five million dollars out of the hundred fifty million be earmarked specifically for the planning of education centers, but that is as far as it goes at the present time. Money will be available for the planning, but we will not have money available to support the construction."

# SURPLUS PROPERTY FOR SCIENCE EDUCATION

Sam G. Wynn
Regional Representative
Division of Surplus Property Utilization
Department of Health, Education, and Welfare

Surplus property has been around for a long time. The first surplus property was disposed of by President Washington. Surplus materials were gathered from the Revolutionary War and Congress authorized their disposal. It was not until 1949 that the Congress enacted the present legislation under which surplus property is disposed of. The agencies and departments of the Federal government very frequently find that they have more real property, the land, buildings and personal property which is all of those things that are movable and not attached, that the agencies may need. This comes about because of the changes in programs, changes in the objectives, and the fact that the Department of Defense can't keep up with the sophistication of the weapons that it acquires.

Federal facility and administrative services active in 1949 provided that the Secretary of Health, Education, and Welfare could make determination of which property the Federal government had that could be used for health or educational programs. Later, there was added the eligibility of Civil Defense. You are interested here today predominantly in those materials that can be used for health and educational purposes. Now, it is true that surplus property is much more difficult to use than the property that can be ordered from the catalogue. For property that is being ordered from the catalogue, all of the supplementary materials and the directions for using the property are available from the organization printing the catalogue. It requires much more initiative and considerable know-how to devise projects that can use government surplus property. Government surplus properties range from refrigerators, incubators, heaters, ovens, sterilizers, temperature controls, instruments involving environmental and altitude changes, all of the things that the agencies or government may use in their programs. Again, these are surpluses; one must always realize that they are not always new; some need repair work, others require the know-how to use them. We would encourage you very much to devote a little bit of your time and attention towards getting the schools within your respective states to be knowledgeable of the surplus property utilization programs that the states operate.

## Highlights of the Discussion of Mr. Wynn's Speech

Mr. Wynn was asked if he knew of any state that is now doing an effective job of distributing surplus property. He replied, "I can answer this question either as a pessimist or an optimist. I'll answer it optimistically. I do know a lot of schools that have gotten a lot of good from the surplus properties that they have received. There could be a much better job done in the distribution of surplus property." In answer to a comment about the difficulty of using Federal materials because of the terminology used in Federal property manuals, Mr. Wyann said, "A great deal of effort has been devoted to providing conversion charts. These have been made available to state agents; and I fee relatively sure that if you would insist, that you, too, could get those from your state agents.

A question was raised concerning the opinion that schools located nearest to Federal installations benefit most from surplus property. Mr. Wynn answered, "Yes, the schools that are close to the Federal installation do probably benefit more than schools that are isolated. The distribution of surplus property is the most difficult activity. There is not an intention that the school located nearby will derive any greater benefit than the school that is isolated. Surplus property is allocated to the state agencies on a formula, which has several factors, but unfortunately the factor that is most readily used is population. All too frequently, this is the only factor that is taken into consideration.

Concerning the charges made for surplus property, Mr. Wynn said, "Each state agency at the state government develops its service charge plan. Those plans, as you have pointed out, vary between every one of the state agents. You, as a citizen of your state, could, and should attempt to develop an influence on the service charge that your agency may be accepting. Raise questions with those service charges, challenge them. This is a policy of your state agent; it is not a policy that has been tossed on the agent by the Federal government. The state agent is not receiving appropriated money selfishly. In order to stay in business, he must assess a service charge. The property itself is donated."

In conclusion, Mr. Wynn suggested, "A good project that could be encouraged by you as a state science supervisor is to find a way to develop projects that can involve the use of surplus property. All these schools do not have the time to go and look to see what the state surplus property agencies now have. Unfortunately, the state agencies do not have now the ability and they do not have the money available to develop projects where they can box up the materials and ship them to the donee without the donee or the school having to come in to look and select. Why not have a few expets go in and identify this property, write up the project, then have the property shipped to the school? We have always said in this program that we have to recognize the head of the school or the head of the physical agents, but there is no reason why the superintendent of the school or the chief physical officer of the school can't delegate that authority to the classroom teacher who knows better than anybody else what that classroom can use."

# SUMMARY AND EVALUATION

# USOE CONFERENCE FOR STATE SCIENCE SUPERVISORS
# SUMMARY AND EVALUATION

George Katagiri
President, Council of State Science Supervisors

The exponential rate at which scientific and technological advancements are being made is one of the major factors which is contributing to the rapidly changing nature of our society. As state science supervisors we are cognizant of the implications that these developments have on science instruction in the public schools. The effectiveness with which we operate will influence the degree of scientific literacy which the citizens of this democracy will attain in the years ahead. Our burden is not a light one. We are obligated to be at the frontier of the advances in science education.

All of us recognize the limitations for professional growth when we work independently or in small groups. The conference of this past week has been an effective avenue for us to objectively reflect on our respective duties and to be exposed to new ideas which have a direct bearing on our everyday responsibilities.

During this conference we have met and interacted with almost no pause. Although trying at times, we realized that every topic on the program was important. The tight schedule reflects the almost overwhelming responsibilities of our position. Realizing this as individuals would be depressing. Understanding it as a group, I hope, will give each one of us the incentive to find newer and better ways of attaining our goals. Our feeling for a common purpose is stronger now than it has ever been before.

Every conference has its highlights. The highlight of the United States Office of Education Conference of State Science Supervisors in Austin started on Tuesday morning and ended this afternoon with some creative demonstrations by our own members.

The four-day conference permitted the introduction of a variety of well-selected topics with an opportunity to examine each one to some depth. These topics had a direct relation to the work of most science supervisors.

One of the major strengths of the conference was the schedule which permitted every conferee to interact freely in the seven small-group sessions. This arrangement permitted time for the clarification, elaboration, and interaction of ideas among individual supervisors. The general sessions which followed the small group meetings were beneficial. Points made by the outstanding resource people were clarified or elaborated further. This interaction between the speakers and the group helped us to gain a keener insight into some of the ideas which are at the frontier of science education.

Another strength of the conference was the arrangement which allowed each conferee to contribute his services and talents before the entire group. The feeling of unity which developed during the conference was a direct outgrowth of the realization that science supervisors, even the freshmen in our ranks, have many talents which can be called upon to accomplish the many tasks necessary to improve the function of science supervision at the state department level.

The selection of topics was well received. Reports and clarification by specialists from the United State Office of Education helped to clarify the many pressing problems being encountered by state science supervisors in the implementation of the NDEA, Title III program. The explanations of the ESEA, Titles I, II, and III program and their relationships to science supervisory personnel were most informative and enlightening. It was evident that face-to-face confrontation was effective in clarifying misconceptions about these programs. The understandings which developed will help science supervisors to be better leaders in their states.

All resource people were most helpful in furthering the purposes of the program. The assessment by Dr. Addison Lee of the role of supervisors of the past and present and his challenge for the course to take in the future helped us to gain a more objective view of our present status. It was an appropriate introduction and set the tone for the many meetings to follow.

On-the-spot observations of teachers and children at the Lucy Read Elementary School who were using the AAAS science program and our meeting with Dr. David Butts helped us to gain insight into a new curriculum innovation. This experience was invaluable to us as we interpret the literature and disseminate program information to teachers and administrators in our respective states.

Dr. Matthew H. Brennan discussed the relationship between outdoor education and science instruction when he expanded the learning environments into the out-of-doors. The logic of his rationale was well-conceived and should challenge science supervisors to exert leadership in a direction which will better fulfill our goal of exposing students to all aspects of their environment.

Basic to all of our programs related to classroom instruction is an understanding of the nature of learning. Professor David Hawkins helped us to gain further insight into the cognitive processes of learning. The key points which he presented made us re-examine some of the practices of present science programs.

In consideration of personal interests, one session was devoted to to topics which were identified by science supervisors before the conference. A lengthy discussion and summary statements by each group helped us to share and gain ideas pertaining to supervision problems not covered by the conference program. These sessions were invaluable in helping supervisors to become more confident and effective in their work.

A welcome break to the grueling pace of the conference came through the geology field trip. Dr. Robert E. Boyer directed all conferees on a first-hand inspection of the outstanding geological formations in the Austin vicinity. His informative explanations tield the elements of geology, economics, and history into an integrated and meaningful picture of the area. It was an excellent example of how geology might be taught in the public schools.

For the most part, the negative aspects of the conference were unavoidable. The discussions brought out many areas which needed further elaboration, but for which time was not available. The tight schedule offered the presentation of a maximum number of topics to consider, but forced a limited reflection of any one of them.

In general, state science supervisors were very pleased to have this opportunity to meet. It would be presumptuous for us to claim that this has been our best conference, but I think we can say that none have been better. The timing of the conference was good. The meeting helped us to better understand ourselves, our tasks, and our relationships to the United States Office of Education. We are appreciative to the Office for making this meeting possible and strongly recommend that similar meetings be held annually.

Any summary and evaluation of this conference would not be complete without some mention of the role of the Texas Agency. Its efficiency in making all of the excellent physical arrangements, the services of its personnel at the conference, and the graciousness and hospitality of its staff were beyond all expectations. Without exception, we are grateful and indebted to the people of this great State.

# PLANNING

## NATIONAL CONFERENCE OF STATE SCIENCE SUPERVISORS

## SUMMARY AND EVALUATION

C. S. Story
Coordinator of Activities

To those of you who were in attendance, a big "thank you" for your cooperation and help in making the meeting a success. The good fellowship was an inspiration in itself. We would like to thank Frank Kizer and those other members of the Steering Committee from the Council of State Science Supervisors: George Katagiri, Gene Maguran, Nadine Dungan, Dick Peterson, Lewin Wheat, and Neal Shedd of the United States Office of Education for initiating and carrying through with the planning of this conference. We wish to express our appreciation for the help which Dr. Marjorie C. Johnston, Dr. Melvin Engelhardt, Dr. Milbrey Jones, Dr. Lee Wickline, Mr. Carter Thorpe, and Dr. Lola Rogers from the United States Office of Education, have given to effect the success of the conference; also to Mr. Wynn of the War Surplus Division. We can thank my colleague Alfred (Pete) Peters who has done a wonderful job in arranging for the physical facilities.

Our purpose in not having formal luncheons and dinners was to give as much free time to the participants as possible to reflect upon what went on in our sessions. Someone has said that, in order to have learning, we must first experience, second reflect, then apply this new knowledge. We have experienced, but the time for reflection may have to be postponed as is so often the case in such meetings. Therefore, because of this and other factors which contribute to the success of a conference, I would like to submit the following suggestions to be considered in planning for any future conference of State Science Supervisors:

1. Allow at least six months after the selection of a site to plan a conference so that time will be allowed to negotiate contracts and obtain qualified people as guest speakers which is so necessary for a smooth-running program.

2. Consider the feasibility of contracting for all local services including meals and rooms rather than giving the participants a per diem.

3. Continue the idea of not having formal sessions at night and of being careful in structuring extra-curricular activities for the evenings which the participant may feel obligated to attend.

4. Arrange for time in the schedule for regular physical fitness activities. (As far as I am concerned, the lack of this is one of the biggest deterrents to a successful conference.) Of all convention people, we science supervisors should be aware of the necessity of regular exercise as a factor in good mental health. I am afraid that too many of us became tired, not because of overwork, but because of physical inactivity during the time between 8:00 a.m. to 5:00 p.m.

5. Make better provision for exchange of materials, curriculum guides, et cetera.

# APPENDIX

# REPORTS OF INTEREST GROUP SESSIONS

On the last day of the conference, a session was devoted to interest groups. The participants attended one of seven group meetings according to their choice. The interest group topics included laboratory safety, laboratory facilities, the use of live animals, teacher preparation, laboratory approach, science and the disadvantaged student and changing objectives in science education. The reports of these interest groups follow.

## I. Laboratory Safety

Laboratory safety, as seen through the eyes of the state supervisors, is a problem which is increasing. This is so because of the new programs in science which do not highlight this factor, as well as the emphasis that is placed on activity and experimentation in the fields of biology, chemistry, earth science, and physics. The problem is felt to be most acute at the elementary level. This is so because of the many new programs and the dearth of preparation in science for most teachers at this level.

Nine recommendations were stipulated by this group. These are recorded in their order of presentation.

1. A task force should be organized to prepare materials which would create an awareness of the problems concerned with laboratory safety. These materials might be in the form of guidelines which could be adapted for use by the various states. The task force should include such organizations as the NABT, ACS, AAPT, AAAS, NASSP, CSSS, and other pertinent organizations. Attention should be paid to construction and design which includes appropriate safety devices.

2. Pre-service teacher preparation must include a strong emphasis on classroom and laboratory safety. AETS needs to be informed of this recommendation.

3. A depository for materials developed should be considered. Materials should be sent to this center as soon as they come about. The elapsed time between the collection of materials and their eventual publication is, in many instances, too great to achieve any real efficiency. It was suggested that HEW serve as a central depository.

4. Prompt communication and dissemination of safety activities within a state needs to be distributed to other states.

5. The Council of State Science Supervisors has initiated efforts directed toward the development of common safety practices. This has been done through a safety check list distributed to all state science supervisors.

6. The Council of State Science Supervisors should communicate an awareness of the need for classroom and laboratory safety in the new elementary science curricula.

7. Supervisors of science are requested to send news clippings of accidents incurred in schools through a lack of classroom or laboratory safety to a central location. This technique would serve in eliciting a greater awareness of the need for safety which could then be made known to the various states.

8. A concern was voiced for making laboratory safety a permanent part of all future conferences of the Council of State Science Supervisors.

9. The committee recommended that the science supervisors in the various states be involved in developing legislation concerned with eye safety and those manuals associated with such materials.

II. Laboratory Facilities

North Carolina has developed a brochure for architects and superintendents giving general broad recommendations for space requirements and facilities layouts. The brochure emphasizes that laboratory facilities must be designed for the curriculum in which they are placed rather than trying to make the curriculum fit into some specified laboratory arrangement. Surveys of curriculum needs must be made before any constructive ideas are decided.

Recommendations:

1. A close working relationship should be developed between state science supervisors and the agencies within states which are responsible for developing and approving school plans. There is evidence within our group that, in some states, there is little willingness of architects and engineers to consult science specialists as new school plans are developed.

2. There are many federal projects in various ESEA titles in addition to NDEA Title III which involve science materials, equipment and facilities. Frequently, state science supervisors are restricted to reviewing only NDEA, Title III projects. It is recommended that the state science supervisors be made aware of proposals which involve science within their state, regardless of the source of potential financing for the projects.

## III. Use of Live Animals

We wish to call the attention of the membership to the current controversy in New Jersey concerning the case of the New Jersey Society for the Prevention of Cruelty to Animals vs. the South Orange Board of Education and others. We believe it would be to the best interests of all charged with science supervision to become familiar with the proceedings of this case and to follow the pending appeal. This suit was brought by the SPCA against the South Orange Board of Education. It charged violation of the state's anti-cruelty laws in one of the public schools. Specifically, it charged a teacher with allowing a student to implant carcinogens in poultry, thus causing pain and discomfort, thereby violating the anti-cruelty statute. The court findings were in favor of the defendants in these words. The type of experiment conducted in this case, as it was, under the circumstances of careful supervision by qualified people did not constitute either an abuse or a needless mutilation or lulling or unnecessary cruelty upon living animals or creatures."

The group believes the prerogative of the teacher in making [illegible] judgments as to the appropriateness of teaching materials and techniques should be preserved. However, the group wishes to emphasize that this prerogative carries a responsibility of making these decisions within the framework of the newer and esthetic values of the community.

Stan Shaw cited instances of poisonous snakes having been brought to the classroom when teachers gave extra credit for bringing in live animals. In one instance, a poisonous snake escaped resulting in the closing of the school for that day.

## IV. Teacher Preparation

1. Colleges and universities, in their teacher education programs, should work with state supervisors in locating teachers involved in the new science curriculums.

2. The confusion of what constitutes a good science program makes it impossible for the group to make a recommendation to colleges at the elementary level. The group recommends that the Council of State Science Supervisors formulate a committee to study the elementary science programs which would culminate in policies and services similar to those developed by CUPM. This would also include a study of certification for teachers of science.

3. State science supervisors should cooperate with other subject area supervisors to promote a state-wide policy of ongoing in-service programs with release time for teachers.

4. The Council of State Science Supervisors should take action to contact appropriate persons in the national associations of supervisors of other subject areas to determine what their policies are on the above stated recommendations.

## V. Laboratory Approach

We first tried to define what is meant by "The Laboratory Approach," and decided that synonyms could be: "laboratory-centered," "laboratory-emphasized," or laboratory-oriented."

In our present day thinking, the first thought that comes to mind concerning the laboratory approach is that we are concerning ourselves with BSCS, CHEMS, PSSC, etc. Our group agreed, however, that good teachers have been utilizing the laboratory approach for many, many years. At this point we slightly sidetracked to a consideration of science fairs relative to the laboratory approach. It was agreed that while the science fair can contribute to the development of the laboratory approach, it can also inhibit it, especially when a teacher teaches only "science fair." We would also suggest the possibility of using an interested college teacher as a resource person for this type of activity. The group agreed that the basic laboratory approach in the classroom should be for all youngsters. It is especially desirable for the slow learner and non-college bound.

Recommendations:

1. The laboratory approach should be involved in the total school program, K-12.

2. At the junior high level, the emphasis should be on a do-it-yourself type of work and should involve a great deal of practical laboratory work.

3. At the senior high level, a minimum of forty per cent of science class time should be devoted to laboratory.

4. Although a good teacher will carry out the laboratory approach no matter what facilities are available, basic facilities are a definite need and should be provided.

5. To have good laboratory-oriented work, a good introduction is needed at the elementary level and junior high level.

6. The laboratory should be an integral part of the classroom. It is often necessary to find ways to convince school boards that this is so.

7. The Council of State Science Supervisors has a major responsibility in encouraging teachers to get the maximum mileage from their laboratories.

## VI. Science and the Disadvantaged Student

There was discussion of the language of the disadvantaged students. It was generally agreed that the language of most deprived children is not adequate for what is expected of them and, thereby, creativity is squelched. It was also agreed that we must accept the cultural differences in their backgrounds in order to teach these children, but do not have to promote certain cultural traits that would be detrimental. Programs in science can help minimize the disadvantages of this situation and also provide the necessary experiences for a learning situation. An experience-based curriculum was suggested; this would use science as a basis for creativity and for overcoming cultural disadvantages.

There was a recommendation to those present that using an interdisciplinary approach, the group establish a science curriculum, with these objectives:

1. To establish concepts in sequence of learning,

2. to describe activities of an experience nature that will develop the concepts in sequence,

3. to develop tests that will determine the status of the pupil and also the progress that he is making in the program,

4. to develop each learner as an individual in his field of interest,

5. and to develop a language which will be suitable for common communication.

## VII. Changing Objectives in Science Education

Since nothing was communicated to us prior to the panel meeting, the group reacted in an initiatory fashion. Nothing stated is either final or absolute.

General statements:

It appears that the trend is one toward giving the discipline back to the children.

The attempt seems to be not necessarily one of changing overall broad objectives but one of more clearly defining and progressing toward them effectively and efficiently.

Day-to-day objectives of scinece education should be both apparent and meaningful in their relation to the overall objectives of science and science education.

Positions:

Since science education is, in fact, in a state of change; it seems necessary that certain fundamental positions be identified in order to make the best decisions regarding these changes as professional leaders.

1. The objectives of science and science education intermesh with the other disciplines.
2. Science and science education is for all students.
3. The society in which we live demands scientific literacy of our present and future population.
4. Some meaningful encounter with science should be available for all students every year.
5. Science should assist the individual in generalizing his past experiences to react effectively to new situations.
6. A critical analysis of educational materials in science should be accomplished in relation to objectives prior to their adoption. This precludes "trend following" but certainly should not preclude science curriculum experimentation.
7. If, in fact, science belongs in the curriculum then it deserves to be supported with the necessary instructional materials, and taught by people knowledgeable in science.

# ABBREVIATIONS

AAAS - American Association for the Advancement of Science
AAPT - American Association of Physics Teachers
ACS - American Chemical Society
AETS - Association for the Education of Teachers in Science
BSCS - Biological Science Curriculum Study
CBA - Chemical Bond Approach
CHEMS - Chemical Education Materials Study
CUEBS - Commission on Undergraduate Education in the Biological Sciences
CSSS - Council of State Science Supervisors
CUPM - Committee on the Undergraduate Program in Mathematics
ERIC - Education Research Information Center
ESEA - Elementary and Secondary Education Act
ESI - Educational Services Incorporated
ETV - Educational Television
HEA - Higher Education Act
HEW - Department of Health, Education and Welfare
MIT - Massachusetts Institute of Technology
NABT - National Association of Biology Teachers
NASA - National Aeronautics and Space Administration
NASSP - National Association of Secondary School Principals
NDEA - National Defense Education Act
NSTA - National Science Teachers Association
PSSC - Physical Science Study Committee
USOE - United States Office of Education

# PROGRAM

Monday, June 13, 1966

| | |
|---|---|
| 4:00 p.m. - 8:00 p.m. | Registration, Wilbur Clark's Crest Hotel |
| 4:00 p.m. - 8:00 p.m. | Steering Committee Meeting |

Tuesday, June 14, 1966

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| 8:00 a.m. - 9:00 a.m. | Registration |
| | General Session Ia, Granada Ballroom<br>Presiding: A. Neal Shedd, Chief, Program Development Section, Division of Plans and Supplementary Centers, U. S. Office of Education, Washington, D.C. |
| | Invocation: Dr. John Barclay, Central Christian Church |
| 9:00 a.m. - 9:15 a.m. | Welcome Dr. Lee Wilborn, Assistant Commissioner for Instruction, Texas Education Agency |
| 9:15 a.m. - 9:30 a.m. | Orientation and History of NDEA Title III, George Katagiri, Science Consultant, Oregon State Department of Education |
| | Dr. Lee Wickline, Chief, Program Management Section, Division of Plans and Supplementary Centers, U. S. Office of Education |
| 9:30 a.m. - 9:50 a.m. | Coffee Break |
| 9:50 a.m. - 11:00 a.m. | Small Group Session I<br>Topic of discussion - "Identification of Needs Related to NDEA Title III" |
| | Break up into seven small groups (C, D, E, F, G, H, I) for analysis of the topic |
| 11:00 a.m. - 12:00 p.m. | General Session Ib, Granada Ballroom<br>Interaction of participants with Dr. Marjorie Johnston, Chief, Instructional Resources Branch Division of Plans and Supplementary Centers, U.S. Office of Education and Dr. Lee Wickline, Chief, Program Management Section, Division of Plans and Supplementary Centers, U.S. Office of Education |

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| 12:00 p.m. - 1:30 p.m. | Lunch |
| | General Session IIa, Granada Ballroom<br>Presiding: Mr. Gene Maguran, Senior Science Specialist, West Virginia State Department of Education |
| 1:30 p.m. - 2:30 p.m. | Topic of discussion: "State Leadership in Science" Dr. Addison E. Lee, Director, Science Education Center, The University of Texas |
| 3:30 p.m. - 2:45 p.m. | Coffee Break |
| 2:45 p.m. - 3:45 p.m. | Small Group Session II<br>Analysis of the topic: "State Leadership in Science" |
| 3:45 p.m. - 5:00 p.m. | General Session IIb, Granada Ballroom<br>Interaction of participants with Dr. Lee |

Wednesday, June 15, 1966

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| 8:00 a.m. - 8:30 a.m. | General Session IIIa<br>Presiding: Mr. C. S. Story, Program Director of Science, Texas Education Agency |
| | Field Trip to Lucy Read Elementary School for demonstration of AAAS Science program and discussion; buses to Lucy Read School |
| 8:30 a.m. - 9:30 a.m. | AAAS orientation period<br>Dr. David Butts, Associate Professor, Science Education Center, The University of Texas |
| 9:30 a.m. | Coffee Break |
| 10:00 a.m. - 10:45 a.m. | Demonstration Class |
| 10:45 a.m. - 11:15 a.m. | Small Group Session III<br>Analysis of AAAS Elementary Program |
| 11:20 a.m. - 12:00 p.m. | General Session IIIb, Lucy Read Elementary School |
| 12:00 p.m. - 1:30 p.m. | Lunch |

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| 1:30 p.m. - 2:30 p.m. | General Session IVa, Granada Ballroom<br>Presiding: Mr. Rodney L. Trantham, Assistant Supervisor for Science, South Carolina Department of Education<br>Topic: "Outdoor Science Education"<br>Dr. Matthew J. Brennan, Director of Field Studies, Pinchot Institute for Studies in Conservation, Milford, Pennsylvania |  |
| 2:30 p.m. - 2:45 p.m. | Coffee Break |  |
| 2:45p.m. - 3:45 p.m. | Small Group Session IV<br>Analysis of the topic |  |
| 3:45 p.m. - 4:45 p.m. | General Session IVb, Granada Ballroom<br>Interaction of participants with Dr. Brennan |  |
| 5:00 p.m. - 6:30 p.m. | Load Bus for Field Trip<br>Geological field trip and group discussion<br>Dr. Robert E. Boyer, Associate Professor of Geology, The University of Texas |  |
| 6:30 p.m. - 9:30 p.m. | Load Boat for Continuation of Geological Field Trip |  |

Thursday, June 16, 1966

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| 8:30 a.m. - 9:45 a.m. | General Session Va, Granada Ballroom<br>Presiding: Mrs. Nadine Dungan, Science Consultant Illinois Department of Education |  |
|  | Topic of discussion: "The Effect of NDEA and Other Federal Programs as Related to Science Supervision at the State Level" |  |
|  | "Title I, ESEA" | Mr.H.E. Phillips, Director<br>Program Development<br>Division of Compensatory Education<br>Texas Education Agency |
|  | "Title II,ESEA" | Dr. Milbrey Jones,<br>Program Specialist, DPSC<br>U. S. Office of Education |
|  | Surplus Property | Mr. Sam G. Wynn<br>Regional Representative<br>Division of Surplus Property Utilization<br>Utilization, Department of Health, Education, and Welfare |

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| 9:45 a.m. - 10:00 a.m. | Coffee Break |
| 10:00 a.m. - 10:45 a.m. | Small Group Session V<br>Group Analysis of Presentations |
| 10:45 a.m. - 12:00 p.m. | General Session Vb, Granada Ballroom<br>Interaction of participants with speakers |
| 12:00 p.m. - 1:30 p.m. | General Session VIa, Granada Ballroom<br>Presiding: Mr. Glyn A. Sharpe, Supervisor of Science Education, Colorado Department of Education<br>Topic of discussion: "The Cognitive Process in Learning Science"<br>Dr. David Hawkins, Professor of Philosophy, The University of Colorado |
| 2:30 p.m. - 2:45 p.m. | Coffee Break |
| 2:45 p.m. - 3:45 p.m. | Small Group Session VI<br>Analysis of the topic: "The Cognitive Process in Learning Science" |
| 3:45 p.m. - 5: p.m. | General Session VIb, Granada Ballroom<br>Presiding: Mr. L. Frank Mann, Science Consultant, California Department of Education<br>Interaction of participants with Dr. Hawkins |

Friday, June 17, 1966

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| | General Session VIII, Granada Ballroom<br>Presiding: Mr. George Katagiri, Science Consultant, Oregon Department of Education |
| 8:30 a.m. - 10:00 a.m. | Interest groups, Session I<br>Mr. Kenneth W. Dowling, Supervisor of Science Wisconsin Department of Education<br>1. Laboratory Safety<br>2. Laboratory Facilities<br>3. Use of Live Animals<br>4. Teacher Preparation<br>5. Laboratory Approach<br>6. Science and the Disadvantaged Student<br>7. Changing Objectives In Science Education |
| 10:00 a.m. - 10:15 a.m. | Coffee Break |

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| 10:15 a.m. | - | 12:00 p.m. | General Session VIII, Granada Ballroom<br>Presiding: Mr. James M. Garner, Supervisor of Science, Washington Department of Education<br>"Effective Supervisory Practices - Reports from the States" |
| 12:00 p.m. | - | 1:30 p.m. | Lunch |
| 1:30 a.m. | - | 5:00 p.m. | Summary and Evaluation of Conference<br>Mr. C. S. (Bill) Story<br>Mr. George Katagiri<br>Dr. Marjorie Johnston |

## DELEGATES TO NATIONAL CONFERENCE OF STATE SCIENCE SUPERVISORS

| | |
|---|---|
| Alabama | Frances D. Jones<br>Science Consultant |
| Alaska | No representatives |
| Arizona | Cletus Miller<br>Science Consultant |
| Arkansas | No representatives |
| California | L. Frank Mann<br>Science Consultant |
| Colorado | Glyn Sharpe<br>Consultant in Science and Mathematics |
| Connecticut | Ralph E. Keirstead<br>Consultant in Science |
| Delaware | Walter E. Steidle<br>State Supervisor of Science |
| Florida | Robert D. Binger<br>Consultant in Science Education |
| | David L. Ramsey<br>Science Consultant |
| Georgia | Dallas Stewart<br>Science Consultant |
| Hawaii | Richard Akiyama<br>Science Consultant |
| Idaho | Richard Kay<br>Science Consultant |

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|---|---|
| Illinois | Nadine Dungan<br>Science Consultant<br>Harold Prehn<br>Science Consultant |
| Indiana | Jerry M. Colglazier<br>Science Supervisor |
| Iowa | Paul Tweeten<br>Science Supervisor |
| Kansas | Jan Holman<br>Science Consultant |
| Kentucky | H. M. Watkins<br>Science Supervisor |
| Louisiana | Stan Shaw<br>Supervisor of Science and Conservation |
| Maine | Donald W. Robinson<br>State Supervisor of Science |
| Maryland | Lewin A. Wheat<br>Supervisor of Science |
| Massachusetts | John W. Packard<br>Senior Supervisor of Science Education |
| Michigan | No representatives |
| Minnesota | Robert Collins<br>Science Consultant |

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| Mississippi | R. C. Roberts<br>Supervisor of Science |
| Missouri | John A. Hooser<br>Science Consultant |
| Montana | No representatives |
| Nebraska | Dale M. Bunsen<br>Science Consultant |
| Nevada | Jack O'Leary<br>Scinece Consultant |
| New Hampshire | Howard I. Wagner<br>Director, Science Eduation |
| New Jersey | Joseph Di Stefano<br>Science Consultant |
| New Mexico | Beverly K. Graham<br>Science Specialist |
| New York | Hugh Templeton<br>Scinece Consultant |
| North Carolina | Y. A. Taylor<br>Supervisor of Science |
| North Dakota | George Fors<br>Science Consultant |
| Ohio | C. K. Bradford<br>Science Consultant |

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|---|---|
| Oklahoma | Floyd Thompson<br>Director of Instruction |
| Oregon | George Katagiri<br>Science Consultant |
| Pennsylvania | Joseph E. Anthony<br>Science Education Specialist |
| Rhode Island | Arthur J. McMahon<br>Mathematics Consultant |
| South Carolina | R. L. Trantham<br>Assistant Science Supervisor |
| Tennessee | Donald Wood<br>Director of Instruction |
| Texas | C. S. Story<br>Program Director of Science |
| | Alfred F. Peters<br>Science Consultant |
| Utah | No representatives |
| Vermont | George Dean<br>Science Consultant |
| Virginia | William S. Young<br>Science Consultant |
| Washington | James M. Garner<br>Supervisor of Science Programs |
| Washington, D.C. | Keith C. Johnson<br>Supervising Director of Science |

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|---|---|
| West Virginia | Gene A. Maguran, Sr.<br>Administrator, NDEA<br>and Title III of ESEA<br><br>Bob Perry<br>Science Specialist |
| Wisconsin | Kenneth W. Dowling<br>Supervisor of Science |
| Wyoming | Paul D. Sandifer<br>Director of Secondary Education |

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